Music listening in the treatment of anxiety disorders: Conceptualisation and proof of concept

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Abstract

This thesis presents the development and implementation of a proof-of-concept study testing music listening's capacity to reduce subjective and physiological symptoms of anxiety in a situation analogous to an anxiety disorder. This interdisciplinary thesis draws on both clinical psychology and music psychology literature to present a conceptualisation for music listening in the treatment of anxiety disorders.

In preparation for the proof-of-concept study, criteria for optimal stimuli were synthesised from the music psychology literature, two optimal stimuli were selected, and an anxiety induction protocol was developed to model the worry-based nature of an anxiety disorder. The two stimuli selected were 'The Swan', from *Carnival of the Animals*, by Camille Saint-Saëns, and a combination of 'Dawn' and 'The Secret', by Dario Marianelli, from the 2005 film *Pride and Prejudice*. In the anxiety induction protocol, participants were told that they would be asked to give a presentation in front of other participants and experimenters (whom they had not yet seen), and that this presentation would be assessed. While they awaited the presentation, participants were asked to do a mental visualisation exercise, which involved thinking about any previous public speaking experience that had made them feel nervous. Participants were given headphones with either music or white noise while they completed this exercise.

The proof-of-concept study was conducted with a general population, with participants (n = 58) randomised to listen to either music or white noise during the anxiety induction protocol.

Subjective anxiety (as per the short form of the state scale of the State Trait Anxiety Inventory, or STAI-SF) and physiological arousal (as per pulse rate and skin resistance) were measured. Physiological arousal measures were taken for one minute at baseline (time 1), for one minute when the participant had been introduced to the task and were reading through the mental visualisation exercise (time 2), and while the participants completed the mental visualisation exercise, and music or white noise was playing (time 3). Subjective anxiety scores were obtained immediately after each physiological time point.

Results showed that subjective anxiety and physiological arousal rose significantly in response to the anxiety induction protocol, and that subjective anxiety and pulse rate decreased significantly in response to the music but remained the same for those who listened to white noise.

Declaration

I declare that the thesis has been composed by me, that the work is my own, and that the work has not been submitted for any other degree or professional qualification.

Ellen Catherine Spaeth January 2015

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Chapter 1 Introduction

The purpose of this thesis is to explore the potential benefits of music listening in the treatment of anxiety disorders. This comprises conceptualisation, via synthesis of existing research, and experimental work, leading up to an analogue, proof-of-concept study that tests the effects of music listening on a general population during an anxiety induction protocol designed to model the worry-based nature of an anxiety disorder.

More specifically, the aims of this thesis are: 1) the identification of musical stimuli conducive to reducing anxiety within the context of an anxiety disorder; 2) the development of an anxiety induction protocol, or stressor, to model an anxiety disorder, and 3) the examination of the effects of listening to the chosen musical stimuli in response to the developed anxiety induction protocol.

In 2000, the Medical Research Council (MRC) published a framework for the development and evaluation of complex interventions. This framework includes five key stages: 1) theory; 2) modelling (phase 1); 3) exploratory trial (phase 2); 4) definitive RCT (phase 3, or main trial); and 5) long-term implementation (where others establish whether results are replicated in the long term in uncontrolled settings). This framework can be seen in Figure 1.1.

In 2008, the MRC revised the framework to make it less linear and more flexible. The revised framework comprises four main, interacting, phases: development, where the evidence base and theory are identified and developed; feasibility/piloting, where procedures are tested; evaluation, where the effectiveness of the intervention is assessed; and implementation, where findings are disseminated, and long-term follow up is carried out.

This thesis reports the preliminary phases needed before definitive RCT or evaluation with a population with anxiety disorders. The main focus of this thesis is an exploratory trial: a proof-of-concept, analogue study with an anxiety induction protocol designed to model the worry-based nature of an anxiety disorder. For the purposes of this thesis, the initial phases have been adapted slightly to better represent the amount of development work needed before definitive RCT. The adapted stages comprise:

- **Literature review**, which includes identification of the theoretical rationale, and a review of relevant evidence.
- **Development,**[1] which includes development of the intervention, of a protocol to model an anxiety disorder, and of methods for an analogue, proof-of-concept study, or exploratory trial.
- **Exploratory trial**, which includes the analogue, proof-of-concept study, conducted within a general population, with an anxiety induction protocol designed to model an anxiety disorder.

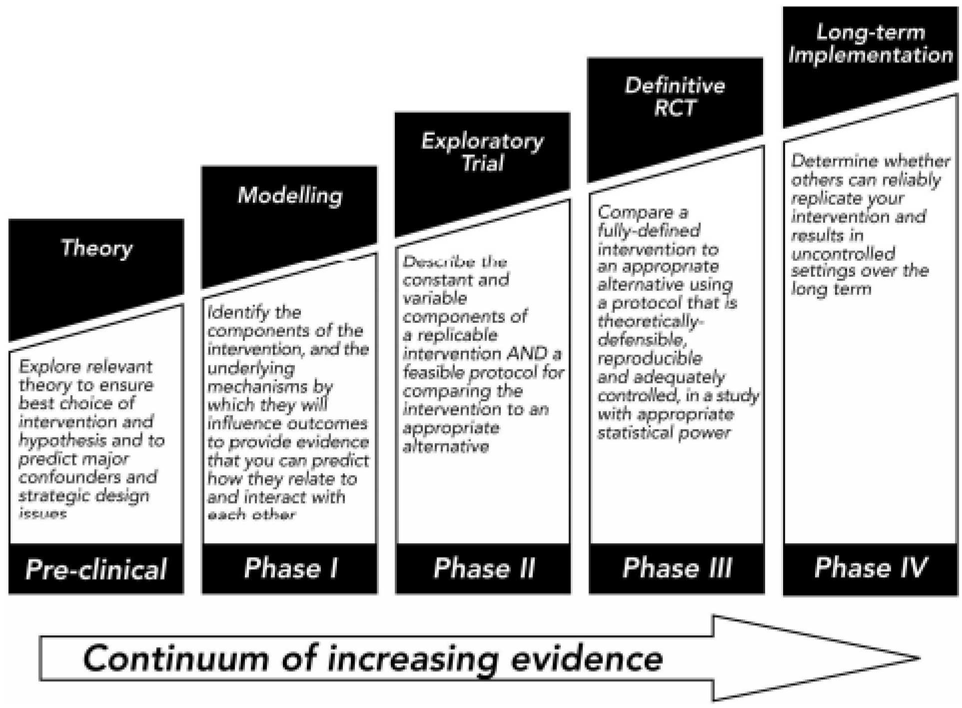

Figure 1.1: MRC framework (taken from MRC, 2000, p. 3)

[1] The development phase here refers to feasibility and pilot studies, as opposed to the development phase of the revised MRC framework, which refers to the development of theory and the assessing of existing evidence.

Due to the limited time and resources afforded to this project, conducting a definitive RCT with a clinical population was not within the scope of this PhD. Rather, the work serves as a building block towards definitive RCT.

The thesis is divided into five chapters. This chapter, Chapter 1, provides an introduction to the thesis itself.

Chapter 2 comprises a review of related literature, divided into three sections. The first section introduces the literature on anxiety disorders. In the second section, the body of research that investigates how listening to music can evoke emotions will be reviewed. These two sections explore the theoretical rationale behind using music listening in the treatment of anxiety disorders. Although music listening has never been tested as an intervention for combatting both the pathological worry and the physiological arousal associated with anxiety disorders, a large number of studies have been conducted which explore how listening to music can reduce anxiety in a variety of contexts. The third section provides a critical review of the evidence coming from this literature.

Chapter 3 reports the developmental work undertaken in preparation for an analogue, proof-of-concept study. This work included selection of optimal stimuli, development of an anxiety induction protocol to model an anxiety disorder, and piloting of the protocol for the analogue study. This phase comprised three stages:

1. Initial stimulus selection

Different music has been shown to promote different affective and physiological responses, and as such not all music will be equally effective at reducing anxiety. For the purposes of this thesis, for the task of reducing anxiety, an optimal stimulus will reduce physiological arousal and increase positive affect. The initial stimulus selection phase was carried out to identify two optimal stimuli for further exploration.

2. Stimulus explorations

Once two optimal stimuli had been selected, two initial exploratory studies were conducted (both with the same cohort). The aims of these were twofold: 1) to explore trends in listening to the optimal “relaxing” stimuli before or after an “anxious” stimulus (chosen to promote increased physiological arousal and negative affect during the stimulus selection phase); 2) to gain further ratings on the selected optimal stimuli, before progressing to a pilot version of the analogue, proof-of-concept study. This was also an opportunity to develop and test various other elements of the methods, such as design, measures, and location.

3. Anxiety induction pilot

The aims behind the anxiety induction pilot were twofold: 1) to include both elements of physiological arousal and worry, and thus model the worry-based nature of an anxiety disorder, and best assess the value of music listening for people with anxiety disorders, and 2) to examine the effects of music listening in response to this anxiety induction protocol, or “stressor”. Methods were also adjusted based on this pilot, and a number of changes were made during this pilot, to refine it for the analogue study.

Chapter 4 reports the analogue, proof-of-concept study.

4. Analogue, proof-of-concept study

After the completion of the pilot phase, a proof-of-concept study was conducted with a larger population (n = 56), using methods informed by the anxiety induction pilot.

Chapter 5 includes a general discussion of the results, and implications for research and practice.

Chapter 2 Literature review

An increasing body of evidence supports the hypothesis that listening to music has the capacity to evoke emotional responses in the listener. Depending on the acoustic properties of the musical stimulus and the experiences of the listener, these responses can include the regulation of physiological arousal and promotion of positive affect in the listener. This thesis explores how music listening's capacity to elicit these responses could be of clinical utility within the context of treating anxiety disorders.

This literature review investigates the theoretical rationale for the use of music listening in the treatment of anxiety disorders and assesses the current level of evidence for music listening's capacity to reduce anxiety in contexts which are not analogous to an anxiety disorder, as a means of establishing a basis for the experimental work reported in this thesis.

The theoretical rationale is based on the following premises, which will be discussed in this literature review:

a) that physiological arousal and worry are components of the anxiety response,
b) that regulating these responses is often an aim of treatment for anxiety disorders,
c) that listening to music can evoke emotional reactions and thus regulate physiological arousal and promote positive affect, and
d) that, according to the mood-as-input theory of perseverative thought, this increase in positive affect could reduce worry.

As such, a role for music listening will be identified as a relaxation technique with the additional capacity to reduce worry, a type of negative perseverative thought.

This PhD has a large translational element, and as such combines research from two main fields: clinical psychology and music psychology. This thesis draws on theories from clinical psychology literature to investigate an application for music psychology research, namely as a means of enhancing treatment for people with anxiety disorders. As such, this literature review covers relevant literature from the fields of both clinical psychology and music psychology, and falls into three sections.

Sections 2.1 and 2.2 explore the theoretical rationale behind using music listening to enhance treatment for anxiety disorders.

Section 2.1 includes an introduction to anxiety disorders. In particular, two mechanisms that perpetuate anxiety disorders are considered: physiological arousal and worry. The role of negative affect in perpetuating worry is examined, with reference to the mood-as-input model of perseverative thought, and a role for music listening in addressing these mechanisms in therapy is identified.

Section 2.2 reviews the body of research that explores how listening to music can manipulate emotions. As emotions have both physiological and affective components (Russell & Barrett, 1999), findings from this literature indicate that listening to music could combat worry (by counteracting negative affect) and physiological arousal. Combining this literature leads to the hypothesis that listening to music could be particularly effective for treating anxiety disorders.

Although music listening has never been tested as an intervention for combatting both the pathological worry and the physiological arousal associated with anxiety disorders, a large number of studies have been conducted which explore how listening to music can reduce anxiety in a variety of contexts. Section 2.3 provides a critical review of this literature.

As such, a gap is identified that this thesis aims to address: Despite decades of research which suggests that listening to music can manipulate emotions, and thus affect and physiological arousal, this research has neither been conceptualised with reference to both worry and physiological arousal, which perpetuate anxiety disorders, nor applied in the context of creating an intervention for people with anxiety disorders. As such, there is currently no study that justifies immediate testing with a clinical population, and an analogue, proof-of-concept study of this type is the focus of this thesis.

However, several authors have considered a potential role for music listening in the context of anxiety disorders. Before moving on to the detailed theoretical rationale for using music listening for people with anxiety disorders, these pieces of literature will be discussed.

Jorm and colleagues (2004) conducted a review which aimed to assess the effectiveness of complementary and self-help treatments for anxiety disorders. This review referred to “music” in general, rather than “music listening” specifically. Although there was evidence to suggest that music could reduce anxiety in anxiety-provoking situations, the authors found no studies that tested this with a population with anxiety disorders. As such, they concluded that there was insufficient evidence to support the use of music in a clinical setting, with no studies conducted that specifically targeted, or attempted to simulate, this group.

Unkefer and Thaut’s edited volume (2005) on ‘Music therapy for adults with mental disorders’ included a brief section considering the potential role of music therapy for treating generalised anxiety disorder (Houghton, Smeltekop, Thaut, Unkefer, & Wilson, 2005). Although active music therapy, which involves participation in musical activities in conjunction with a registered music therapist, rather than just listening to music, was the focus of much of their suggestions, music listening is mentioned. Musical relaxation techniques are suggested as potentially useful for regulating the physiological arousal associated with acute levels of anxiety.

In addition, in the first chapter of this book, Thaut (2005) connects music’s ability to promote positive affect with literature exploring how positive affect can facilitate changes in behaviour, such as improving emotional processing. Although the majority of his suggestions relate to music therapy, rather than music listening, some are relevant to both, in particular, his proposal that music can aid one’s own emotional regulation.

Thaut’s proposal that music’s capacity to evoke physiological and affective responses could have benefits for adults with mental disorders has parallels to this thesis. However, nearly twenty-five years have passed since this argument was made, with the first edition published in 1990, and the literature review in this thesis considers a conceptualisation informed by recent discussions in both clinical psychology (regarding the treatment of anxiety disorders) and in music psychology (regarding optimal stimuli for reducing physiological arousal and negative affect), as well as a more targeted focus regarding the population of interest: individuals with anxiety disorders.

2.1 Anxiety and anxiety disorders

This section of the literature review undertakes a selective discussion of literature related to anxiety and anxiety disorders, including recent debates surrounding anxiety disorders and their treatment. The aim is not to provide a thorough review of all current literature on the subject of anxiety and anxiety disorders, but rather to focus on the research that is most relevant for the purpose of this thesis: to consider the theoretical rationale for the application of music listening as part of treatment for people with anxiety disorders.

In this section, two potential applications are identified for music listening within the treatment of anxiety disorders. These utilities are based on music psychology research that has demonstrated that listening to certain types of music has the capacity to reduce physiological arousal and promote positive affect, which will be discussed in further detail in Section 2.2.

The first application conceptualises music listening as a relaxation technique to be used within exposure therapy, based on music listening's capacity to reduce physiological arousal. The theory behind exposure therapy, and literature on conditioning, is introduced, alongside a discussion of literature exploring the rationale behind, and debates regarding, the use of relaxation techniques in the context of exposure therapy.

Following this is a discussion of a second, more general, potential application for music listening: as a tool for reducing worry. Discussion of music listening's theorised capacity to reduce worry is conceptualised in relation to literature examining the relationship between negative affect and worry, namely that which investigates the mood-as-input hypothesis of perseverative thought, rather than focusing on application within a specific element of treatment. Research on the mood-as-input hypothesis suggests that negative affect can interact with stop rules favoured by those with anxiety disorders to promote negative, perseverative thought, such as worry. As such, music listening is conceptualised as a tool that could be used to promote reduced negative affect, and thus reduced worry.

2.1.1 Introduction to anxiety disorders

People with anxiety disorders experience symptoms of fear and anxiety that are disproportionate to how threatening a situation is. These symptoms include increased physiological arousal, thoughts of danger, and attempts to escape in the situation itself, and negative perseverative thought, such as worry, muscle tension, and avoidance, in the context of potential future encounters with the situation.

It is considered developmentally normative, even adaptive, to feel fear or anxiety in response to potential harm, and indeed to attempt to escape or avoid dangerous situations, as these reactions are a means of reducing threat. However, individuals with anxiety disorders tend to interpret ambiguous situations as dangerous, and as such experience these emotional responses in situations that hold very little threat, resulting in avoidance tactics being employed in relatively safe situations. The increased occurrence of perceived danger means that individuals with anxiety disorders experience frequent subjective distress. In addition, the steps taken to avoid situations perceived as dangerous can cause substantial impairment. It is the combination of this increased subjective distress and the impairment experienced by the individual that distinguishes an anxiety disorder from normative anxiety.

The concepts of fear and anxiety are often conflated in the literature, but when a distinction is made between the two it is temporal in nature: Whereas anxiety is anticipatory, based on potential future threat, fear is the alarm response experienced when threat is actually perceived, whether real or imagined (Cisler, Olatunji, Feldner, & Forsyth, 2014; Craske et al., 2011). According to DSM-5 (American Psychiatric Association, 2013), fear is characterised by surges in physiological arousal and escape behaviours, whereas anxiety is marked by muscle tension and being vigilant towards and avoidant of potential future threat. DSM-5 acknowledges that there is a degree of overlap between these constructs. Indeed, research has shown that worry, which is a type of negative, perseverative thought pattern focused on future threat, and therefore could be considered an anxiety symptom, has been associated with increased physiological arousal, and this is discussed in more detail in Section 2.1.4. Because of this overlap, the term “anxiety” is used throughout the majority of this thesis to refer to the experience and symptoms of both fear and anxiety.

This thesis explores the potential capacity of music listening to regulate fear and anxiety symptoms experienced by those with anxiety disorders, specifically physiological arousal and worry. According to the fourth version (text review) of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR, American Psychiatric Association, 2000), which was the latest version during the initial conceptualisation of this thesis, anxiety disorders include panic disorder, agoraphobia, specific phobia, social phobia, obsessive-compulsive disorder, posttraumatic stress disorder, acute stress disorder, and generalised anxiety disorder, as well as anxiety disorders due to other medical conditions or substance abuse.

In 2013, the fifth version was introduced (DSM-5, American Psychiatric Association, 2013). In this version, changes were made to the category of anxiety disorders. Obsessive-compulsive disorder was removed from the category, and instead became part of a new category on obsessive-compulsive and related disorders. Acute stress disorder and posttraumatic stress disorder were moved to a new category on trauma- and stressor-related disorders.

Although this thesis is conceptualised to relate specifically to anxiety disorders, music listening could also be beneficial within these new categories of obsessive-compulsive and related disorders and trauma- and stressor-based disorders. However, this is not to say that music listening has the capacity to be equally effective in all manifestations. For example, some trauma- and stressor-related disorders are characterised by symptoms of fear and anxiety, and others are marked by more externalising, aggressive, or dissociative symptoms (American Psychiatric Association, 2013). The conceptualisation presented in this thesis discusses the capacity of music listening to benefit those manifestations where fear and anxiety symptoms are focal, rather than those with externalising, aggressive, or dissociative symptoms.

Equally, the relevance of each of the two proposed applications for music listening (in regulating physiological arousal and in reducing worry) is dependent on symptom manifestation. For example, music listening's theoretical role within dysfunctional perseverative thought, such as worry, could also relate to those obsessive-compulsive and related disorders characterised by repetitive mental acts (as per American Psychiatric Association, 2013), whereas the capacity to reduce physiological arousal could be more useful for those marked by repetitive behaviours within the context of in-vivo (real life) exposure.

This thesis focuses on music listening's capacity to manipulate the mechanisms of physiological arousal and worry. Although this capacity could be of relevance to various therapeutic contexts, this thesis uses a cognitive behavioural lens to consider the potential application of music listening.

2.1.2 Conditioning

From a behavioral perspective, a core mechanism in the aetiology and maintenance of anxiety disorders is conditioning (Mineka & Zinbarg, 2006), which suggests that a neutral stimulus can become conditioned (known as a conditioned stimulus, or CS) when it is repeatedly followed by an aversive stimulus (unconditioned stimulus, or US). Once this conditioned pairing occurs, the individual develops a conditioned response (CR), based on the association between the CS and the US, that is, the mental assumption that presentation of the neutral stimulus will always be followed by the aversive stimulus. This conditioned response is characterised by anticipation of the aversive stimulus whenever the neutral stimulus is experienced, and associated symptoms of fear and anxiety. Future avoidance of the CS typically follows, which serves to reinforce the perceived threat of the CS, and thus the association between the CS and the US.

Although repeated presentation of the CS and US in tandem is often how conditioning occurs, it is not necessarily a prerequisite. For example, it has been shown that it is possible for conditioning to happen from just observing someone else experiencing an anxiety-provoking situation or responding fearfully (Olsson & Phelps, 2004), known as “vicarious conditioning” (Mineka & Zinbarg, 2006). Similarly, experiencing the repeated presentation of the CS and the US does not mandate that conditioning will occur (Mineka & Zinbarg, 2006).

It has been repeatedly demonstrated that people with anxiety disorders show an increased attentional bias towards threat (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; Cisler & Koster, 2010), and this attentional bias is a component of cognitive theories of anxiety. This attentional bias is relevant within the context of reencountering, or the anticipation of reencountering, the CS. Rather than being specific to a single disorder, attentional bias to threat has been found to occur in all anxiety disorders, and is believed to be related to increased trait anxiety (Cisler & Koster, 2010). Elevated trait anxiety, which refers to a personality characteristic defining how an individual responds to anxiety, is not necessary an indication of an anxiety disorder within an individual, but it is considered an marker of a predisposition to develop an anxiety disorder (Barlow, 2002).

Cisler and Koster (2010) considered the mechanisms behind this attentional bias towards threat in their review article. Although there are a number of psychosocial models exploring the attentional bias experienced by those with anxiety disorders, there is little consensus on the mechanisms behind or components of this bias. For example, there is contention regarding at what stage of information processing this attentional bias occurs (i.e. automatic, strategic, or both). Many models propose that an automatic threat detection mechanism plays a role in noticing threat and devoting attention to that threat (Bar-Haim et al., 2007; Beck & Clark, 1997; Eysenck, Derakshan, Santos, & Calvo, 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Ohman, 1996; J. M. G. Williams, Watts, MacLeod, & Mathews, 1988), although Wells and Matthews (1994) argue against this, favouring a view that attentional bias is purely strategic.

Some models suggest there is a strategic resource allocation mechanism (Bar-Haim et al., 2007; Mogg & Bradley, 1998; J. M. G. Williams et al., 1988), which assesses the available resources to devote to the threat, and some suggest a type of strategic threat elaboration mechanism, where threat is assessed and classed as either major or minor (Bar-Haim et al., 2007; Beck & Clark, 1997). Another shared proposed mechanism is a strategic goal engagement mechanism, where the individual's goals and efforts can affect attention to threat (Bar-Haim et al., 2007; Eysenck et al., 2007; Mathews & Mackintosh, 1998; Wells & Matthews, 1994). However, Mogg and Bradley (1998) and Williams et al. (1988) propose that attentional bias is purely automatic.

Cisler and Koster (2010) argued that empirical evidence supports the existence of both automatic and strategic processing. They cited findings from studies using masked stimuli to provide support for the hypothesis that attentional bias towards threat can occur automatically for those with specific phobia (van den Hout, Tenney, Huygens, & De Jong, 1997), posttraumatic stress disorder (Harvey, Bryant, & Rapee, 1996), generalised anxiety disorder (B. P. Bradley, Mogg, Millar, & White, 1995), and high trait anxiety (van Honk et al., 2001), findings from studies using supraliminal stimuli (such as Koster, Crombez, Verschuere, & Houwer, 2006) to support the existence of strategic processing. Masked stimuli are shown to participants for a very short amount of time, and then replaced by a similar, neutral stimulus before the participant would have consciously registered the stimulus, whereas supraliminal stimuli are presented at a level that individuals can detect consciously. However, although masked stimuli do remove the opportunity for strategic reactions, because they are not perceivable at a conscious level, supraliminal stimuli do not preclude automatic processing. As such, although it can be difficult to disentangle these phases of information processing, there is evidence to suggest that attentional bias to threat occurs both automatically and strategically.

As well as being likely to perceive situations as threatening, research has also suggested that individuals with anxiety disorders are likely to have dysfunctional emotion regulation in response to this perceived threat (Amstadter, 2008). For example, Gross and Muñoz (1995) proposed that people with anxiety disorders are more likely to attempt to regulate perceived negative emotions, such as by avoidance, which is a common strategy used by people with anxiety disorders when faced with the possibility of reencountering a conditioned stimulus. Many emotion regulation strategies are not adaptive or maladaptive in themselves, rather their benefit or harm derives from the context in which they are used. For example, while avoidance may be an adaptive strategy in some situations, for example when real danger is present, it is considered a particularly maladaptive strategy for individuals with anxiety disorders because it reinforces the threatening nature of the situation. As research strongly suggests that those with anxiety disorders have an attentional bias towards threat, they are more likely to perceive safe situations as threatening, and therefore to employ avoidance when it is unnecessary.

Mennin and colleagues (2002; 2004) proposed a model of emotion regulation dysfunction in generalised anxiety disorder (GAD). This model posited that those with GAD experienced emotion regulation dysfunction in that they felt emotions particularly intensely, understood them poorly, reacted badly to them, for example by being afraid of them, and attempted to regulate them maladaptively.

Elements of the emotion dysregulation model of GAD were tested in a series of studies conducted by Mennin and colleagues (2005). In the first study, participants (undergraduate students, n = 538) completed a series of questionnaires, which tested affective control, alexithymia, emotional intelligence, emotional expressivity, worry, state and trait anxiety, and depression, as well as diagnostic criteria for GAD.

Based on the diagnostic criteria, GAD was present in forty-seven participants, leaving 491 participants as controls. Results showed that GAD individuals reported experiencing emotions more intensely, understanding them more poorly, and expressing negative moods more often than control individuals. GAD individuals also reported increased fear of negative emotions, and believed that they would be less able to soothe themselves in the presence of negative mood compared with control participants. Finally, emotion dysregulation was an effective predictor of GAD, even after controlling for trait anxiety, worry, and depression. This study provided preliminary support for the emotion dysregulation model of GAD, but is limited in that it relies on self-report data for both the purposes of dividing participants into GAD or control conditions and for providing the experimental data. As such, hypotheses are only supported in that individuals who believed they met the diagnostic criteria for GAD were found to experience various components of emotion dysregulation. It is possible that individuals' tendencies when completing self-report questionnaires are a moderating factor.

In a second study by Mennin and colleagues (2005), participants from a clinical population ($n = 42$) and control participants ($n = 55$) completed the same questionnaires. The clinical sample had previously obtained a diagnosis of GAD at a specific clinic. As in the first study, the GAD group reported having more difficulty understanding emotions, more fear of negative consequences from emotions, and greater difficulty soothing themselves after negative emotion. This study provided additional support for components of the emotion dysregulation model, in particular by including a previously-obtained diagnosis of GAD rather than relying on individuals' own perceptions of the presence of diagnostic criteria.

In the third and final study reported by Mennin and colleagues (2005), negative moods (specifically sadness and anxiety) and neutral mood were induced using music. Sadness was induced using 'Russia under the Mongolian Yoke', by Sergei Prokofiev, and anxiety was induced using 'Erwartung', by Arnold Schoenberg, both of which had been found to be effective in eliciting the target emotion in previous studies. 'Waltz of the Flowers' from *The Nutcracker Suite*, by Pyotr Illyich Tchaikovsky, was used to evoke neutral mood. A pilot study was used to assess the neutrality of this piece, with results showing no significant effects for anxiety or sadness. However, as no mention of tests exploring other emotional responses to this piece are outlined, it cannot be assumed that the music is truly neutral, merely that it had not been found to induce sadness or anxiety in the pilot study.

Paired t-tests showed that participants in the anxious mood induction experienced increased anxiety ($p < .001$) and depression ($p < .008$). Similar results were found for those in the sadness induction (both $p < .001$). Those in the neutral induction experienced no increases in anxiety or depression. As such, both negative mood inductions were indeed effective at inducing negative affect, but not a specific, targeted mood state, while the neutral mood induction resulted in increases in neither target affective state, as hypothesised. The two negative mood states were pooled into a single 'negative' induction for subsequent analysis. It remains unclear whether the induction was truly neutral, as other affective states could have been evoked by the 'neutral' music. Indeed, GAD participants who listened to this piece experienced a decrease in self-reported symptoms of physiological anxiety, and a number of participants told the experimenters that they found the piece calming. GAD individuals in the negative condition reported greater physiological anxiety symptoms than control participants ($p < .05$) and greater difficulties in accepting and influencing their negative affective state ($p < .05$).

This series of studies supported elements of the emotion dysregulation model of GAD, in that GAD individuals experienced emotions more intensely than control individuals, and had greater impairments in identifying these emotions. GAD individuals had less belief in their ability to self-soothe in the presence of negative mood, and experienced increased reported physiological anxiety symptoms after a negative mood induction in comparison to controls.

Cisler and colleagues (2014) proposed that an individual's emotion regulation affects their likelihood of developing an anxiety disorder after they have developed a conditioned response. They introduced two processes to illustrate this proposal. The first process relates to how emotion regulation strategies affect the fear experienced when encountering a conditioned stimulus, and posits that strategies involving suppression or negative reappraisal will increase behavioural, physiological, and cognitive components of fear. Individuals may interpret this increased fear as a sign of threat, and thus may experience a reinforcement of the conditioning. In addition, this fear may facilitate avoidance, removing the opportunity to learn that the conditioned stimulus is not always associated with a negative response.

The second process relates to the long-term effects of emotion regulation strategies, suggesting that heightened fear and avoidance in one reencounter can lead to increasingly severe fear and avoidance in subsequent encounters with the conditioned stimulus. As well as providing further negative reinforcement, this could account for the functional impairment seen in individuals with anxiety disorders. Although there is little evidence examining long-term effects of emotion regulation strategies, this process, in addition with the first, reinforces the importance of encouraging individuals with anxiety disorders to reencounter the conditioned stimulus without employing contextually-maladaptive strategies such as avoidance.

2.1.3 Exposure therapy

Exposure therapy is a behavioural psychotherapeutic approach to treating anxiety disorders that focuses on extinction[2] of the conditioned fear.[3] During exposure therapy, individuals are 'exposed' to the CS without the presence of the US. In general, exposure is an attempt to decrease the prominence of the CR when the individual is in the presence of the CS, and to minimise avoidance, which can be maladaptive because of its role in reinforcing the perceived threat of the CS.

Exposure therapy is a core component of cognitive behavioural therapy (CBT) for anxiety disorders (Craske, Treanor, Conway, & Zbozinek, 2014). A meta-analysis by Hofmann and Smits (2008) showed that CBT was more effective than placebo in treating adult anxiety disorders. This meta-analysis included 27 studies, which referred to adult participants with a diagnosis of an anxiety disorder, and included CBT and placebo (no treatment) conditions. Pooled effect size (Hedge's *g*) of CBT (as opposed to placebo) was 0.73 ($p < .001$), suggesting that CBT was significantly, and greatly, more effective than placebo.

Similarly, Cartwright-Hatton and colleagues (2004) conducted a systematic review reviewing CBT for children and adolescents with anxiety disorders. Their review included 10 randomised control trials (RCTs), all of which referred to participants

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[2] It should be noted that, within this context, extinction does not refer specifically to the erasure of the association between the CS and the US, rather to the general reduction of the prominence of the association.

[3] Although the term 'fear' is commonly used in reference to conditioning, especially in relation to Foa and Kozak's (1986) influential model of emotional processing of fear, the symptoms experienced relate to both fear (in the moment of threat), and anxiety (in the anticipation of future threat).

under 19 years old with a diagnosed anxiety disorder, and had a control of no treatment. The authors were interested in rate of remission. They found that CBT was more effective than the no-treatment control, and calculated that participants in the CBT condition had a 56.5% chance of remission, compared with the control condition, who had a 34.8% chance. Although this review showed that CBT was more effective than no treatment, over 35% of participants were found to relapse, suggesting that more investigation into ways to improve this treatment is warranted.

Relaxation techniques are commonly used to facilitate reductions in physiological arousal during exposure therapy in the context of CBT (Borkovec, Newman, & Castonguay, 2004b). Relaxation techniques are taught to individuals within therapy, and are then practised by the individual and used during exposure.

In this thesis, a role is identified for music listening as a relaxation technique, based on the capacity of music listening to reduce physiological arousal (see Section 2.2 for more information). Although relaxation techniques are often used within exposure therapy, there is some controversy regarding their use (D. A. Clark & Beck, 2010). As such, this part of the literature review looks at the rationale behind and debates surrounding the use of relaxation techniques in the context of exposure therapy.

Early exposure therapy focused on the use of systematic desensitisation, developed by Wolpe (1958). Systematic desensitisation is based on the premise that reducing the symptoms of anxiety during exposure can lessen the association between the CS and the US. This proposed mechanism was termed reciprocal inhibition. In systematic desensitisation, individuals are exposed to graduated fear-inducing stressors, while using relaxation techniques to minimise symptoms of anxiety. Within systematic desensitisation, individuals would first be exposed to mild stressors, and would then use techniques to promote relaxation during this exposure, in a bid to counter the anxious response. Once the anxious symptoms had been conquered during exposure to a mild stressor, individuals would be presented with increasingly severe stressors.

Related to reciprocal inhibition is the concept of habituation, a core premise behind Foa and Kozak's emotional processing theory (1986). According to emotional processing theory, habituation facilitates cognitive change. Habituation is posited to occur when the fear associated with the conditioned response is triggered (known as the 'fear structure'), while information incompatible with the fear structure is presented. In this way, individuals develop a new conceptualisation of the conditioned stimulus, which does not contain the aversive, unconditioned stimulus. Exposure therapy guided by habituation focuses on initial triggering of fear, followed by a reduction of these symptoms. The success of this type of therapy has generally been judged based on measures of decreased fear symptoms within exposure therapy (within session) and outwith therapy (between session), with within session decreases of fear symptoms theorised to result in between session decreases.

Using relaxation techniques could be argued as a means of providing information that is incompatible with the fear structure. Indeed, the very aim of using relaxation techniques is to facilitate a reduction in symptoms. However, it could be argued that using relaxation techniques reduces the effectiveness of exposure therapy because, by reducing symptoms of anxiety, they prevent individuals from experiencing the full fear structure.

Another proposed mechanism behind exposure therapy is inhibitory learning, which posits that it is not the weakening or removal of the existing association between the CS and the US that is responsible for the effectiveness of exposure therapy, but the creation of a new association which inhibits the existing association (Bouton, 1993; Bouton & King, 1983). Impaired inhibitory learning has been implicated in the context of anxiety disorders in that those with anxiety disorders have difficulty viewing some situations as safe, due to their attentional bias to threat (Craske, Liao, Brown, & Vervliet, 2012).

These mechanisms are not necessarily mutually exclusive (Myers & Davis, 2007), and share some characteristics. Reciprocal inhibition, habituation, and inhibitory learning all rely on exposure to the CS, and on reducing the prominence of the CR, either by weakening the association itself, or by developing a new, conflicting association. Similarly, all three mechanisms agree that minimising avoidance of the CS is key. However, while advocates of systematic desensitisation might view relaxation techniques as a means of minimising avoidance from the CS itself, this view is not shared by proponents of inhibitory learning. Craske and colleagues (2012) suggest that reduced fear symptoms during exposure prevent inhibitory learning from occurring, and that exposure therapy should aim to remove safety behaviours designed to reduce fear symptoms.

Some researchers, such as Dugas and colleagues (2007) argue that using techniques like distraction during exposure can serve as a type of avoidance in itself, and one could argue that relaxation techniques are a form of distraction. Indeed, relaxation techniques have been identified as safety behaviours, which are efforts or behaviours taken by an individual to lessen perceived threat (Kamphuis & Telch, 1998).

Safety behaviours are generally considered harmful, serving to decrease functioning and maintain the anxiety disorder. According to Salkovskis and colleagues, they "are intended to avoid disaster, and these responses have the secondary effect of preventing the disconfirmation that would otherwise take place" (Salkovskis, Clark, Hackmann, Wells, & Gelder, 1999, p. 573). Indeed, some treatment models, such as Beck's cognitive model of anxiety, emphasise the elimination of safety behaviours to best facilitate therapeutic progress.

But how can we distinguish these harmful safety behaviours from helpful, adaptive, coping responses? Both have the effect of reducing short term anxiety, but only safety behaviours are considered to have negative long term implications (Gelder, 1997), as Thwaites and Freeston (2005) discussed in their review on the subject. On the surface it is not usually possible to brand all instances of a specific behaviour (i.e. relaxation) as harmful or helpful. Instead, context must be considered. Thwaites and Freeston concluded that, as the same action could be considered either a harmful safety behaviour or a helpful coping response, we need to consider both the intention of the individual and the consequences of the action when trying to distinguish between the two.

Regarding the intention of the individual, Thwaites and Freeston argue that the distinction must be made between whether the behaviour is a way for the individual to reduce the anxiety in this situation, or whether it is a way of preventing some sort of “imagined catastrophe” (p. 180). The former is representative of a coping response, the latter of a safety behaviour.

Regarding the consequences of the action, we should consider whether the action is having negative effects: By definition, a safety behaviour has long term negative effects, while a coping response does not. Indeed, studies have considered the negative effects of safety behaviours, exploring how harmful they really are.

Rachman and colleagues (2008) proposed that “judicious” use of safety behaviours – defined as “the careful use of safety behaviour, with an emphasis on the early stages of treatment” (p. 163) – could actually facilitate therapeutic progress. In particular, they suggest that safety behaviours could increase tolerability of exposure therapy, which, while considered an incredibly effective technique, is prone to high dropout and refusal rates. In improving engagement with exposure therapy, safety behaviours could actually help individuals with anxiety disorders to gain disconfirmatory information about trigger stimuli by increasing exposure to these stimuli. The authors hypothesised that, in this way, safety behaviours could be especially useful in the early stages of treatment, and for those with particularly high levels of anxiety.

Because of the high refusal and dropout rates for exposure therapy for individuals with obsessive-compulsive disorder (OCD), Levy and Radomsky (2014) wanted to investigate whether using safety behaviours could potentially increase acceptability of in vivo exposure therapy for this group. Participants (n = 70) from a general, non-clinical population underwent the behavioural approach test (BAT), which asks participants to approach contaminated objects, and thus mimics contamination-based OCD. Participants were assigned to either exposure and safety behaviour (ESB, where they were allowed to put on rubber gloves) or just exposure (control) condition. Results showed that, compared to the control condition, individuals in the ESB condition rated the exercise as significantly more acceptable (p = .009) and took significantly more steps towards the contaminated object than those in the control condition ($p < .001$).

Levy and Radomsky argued that judicious use of safety behaviours could increase acceptability of exposure therapy for those with OCD, without necessarily damaging treatment outcomes, although these were not measured specifically in this study. They recommended further research with a clinical population.

Pending this research, safety behaviours should not be ruled out indiscriminately. It seems that they can make exposure therapy more acceptable, which opens this evidence-based, effective, technique up to more individuals. Even within the context of inhibitory learning, where reducing anxiety responses is not considered a necessary aspect of exposure therapy, relaxation techniques could function as a means of making exposure therapy more tolerable to those who might otherwise refuse exposure therapy.

The term 'safety behaviour' in itself is problematic. Safety behaviours can be considered emotion regulation strategies that are being used maladaptively (Helbig-Lang & Petermann, 2010), and as previously discussed, the maladaptiveness of safety behaviours and emotion regulation strategies is usually context-dependent. An activity that is adaptive in one person could be maladaptive in another. Reducing maladaptive behaviours is an important component of treatment for anxiety disorders, but a blanket denouncement of all activities that have the potential to be maladaptive seems unnecessary.

As such, music listening, with its ability to regulate affect, has potential utility as a relaxation technique. In addition, music listening may have the ability to go beyond existing relaxation techniques, and to also play a role in reducing worry.

2.1.4 Worry

Excessive, pathological worry, which is a form of negative, perseverative thought surrounding future situations (Papageorgiou, 2006), has been identified as a common feature in all anxiety disorders (Barlow, Raffa, & Cohen, 2002). Worry is particularly prominent in generalised anxiety disorder (GAD), for which excessive worry is the cardinal diagnostic feature, as per DSM-5 (American Psychiatric Association, 2013).

It should be noted that this type of worry is generally considered to be distinct from normal, everyday, non-pathological worry (Holaway, Rodebaugh, & Heimberg, 2006). Although the content of worries is often similar (Papageorgiou, 2006), the way the worrier views these worries is very different. For example, individuals with GAD are thought to have both positive beliefs (such as thinking that worrying is helpful and serves a purpose) and negative beliefs (such as thinking that worry is driving them crazy and will have negative repercussions on their life) about worry (Wells, 2006). In addition, those with pathological worry are likely to persevere with negative thinking for longer than those without (Davey, 2006b). Indeed, dysfunctional perseveration has been identified as the hallmark of pathological worry (Davey, 2006a).

According to Borkovec's theory of avoidance (2004a), worry can act as a form of avoidance for individuals with generalised anxiety disorder (GAD). Because anxiety triggers are usually internal for people with GAD, rather than relating to a specific, tangible object or situation, avoidance for them is less likely to comprise avoiding a physical situation, and more likely to consist of an internal cognitive effort.

As such, Borkovec's theory proposes that worry acts as an internal, cognitive, avoidance response for people with GAD, in part because worry is thought to involve verbal and linguistic, rather than imaginal, activity. Borkovec argues that this means that worry results in decreased physiological anxiety responses, and as such interferes with the emotional processing of fear, meaning that the conditioned response remains in place. In addition, the worry is negatively reinforced, as it served to reduce the anxious reaction.

However, the assertion that worry acts as a form of avoidance has been contested, for example by Newman and colleagues (2013) in their recent review on worry within generalised anxiety disorder, which posed a new theoretical model: the contrast avoidance model.

Newman and colleagues argue that worry actually creates and maintains negative affective and physiological experiences, and that this is done intentionally by those with GAD. They propose that what individuals with GAD fear is affective contrast, specifically the change from positive to negative affect, and that worry is used to prepare for this “because [individuals with GAD] prefer to experience a sustained state of distress as a way to be emotionally prepared for the worst possible outcome to various events” (p. 278).

Although CBT is currently considered the optimal treatment for GAD, Newman and colleagues highlight the need to develop more cognitive behavioural therapeutic techniques, with a focus on more tailored approaches, to be able to best address varying manifestations of GAD.

2.1.5 The mood-as-input model of perseverative thought

The theoretical basis for the hypothesis developed in this thesis, that music listening may be used to combat worry, stems from 1) music’s capacity to promote positive affect in the listener. The literature surrounding this will be discussed in Section 2.2; and 2) the mood-as-input model of perseverative thought, which posits that a person’s interpretation of their mood can affect their behaviour (Davey, 2006a). Research has shown that negative affect is associated with increased perseverative thought. As such, Davey proposed something that could counter this affective response could be a worthwhile method of reducing worry.

Johnston and Davey (1997) investigated the role of mood in negative perseveration by randomising participants (n = 30), who were tested individually, to see TV news clips of either positive, negative, or neutral valence, depending on experimental condition. The experimenter then used the catastrophising interview technique (Kendall & Ingram, 1987; Vasey & Borkovec, 1992) to encourage participants to worry about a subject they had identified prior to viewing the TV clips. In the catastrophising interview technique, the experimenter asks the participant questions about their previously-identified worry topic, such as what worries them most about their topic. The participant’s answers are used to inform the next question, resulting in a cascading number of possible negative outcomes, referred to as steps. This is intended to simulate the catastrophising, perseverative nature of worry. When the participant either cannot or will not give any more answers, or if they repeat a previous answer more than twice, the interview is terminated. Results showed that those who watched the negatively-valenced TV clips took significantly more catastrophising steps than those who watched the positive or neutral clips ($p < .05$). This study demonstrated that negative mood is not merely a symptom of worry, but is also a contributing factor in the maintenance of worry because of its ability to promote perseverative thought (Davey, 2006b). However, it is unclear how different types of negative mood might affect the catastrophising steps taken. For example, sadness, fear, anger, and anxiety could all be considered negatively-valenced, but they may not necessarily have similar impacts on perseverative thought.

These results were replicated in a similar study by Startup and Davey (2001). In this study (n = 90), mood was induced using music listening, with stimuli chosen by a pilot study: Vivaldi's *The Four Seasons* for the positive condition, Chopin's *Waltz* in the neutral condition, and Ligeti's *Lux Aeterna* for the negative condition. Although the names of the pieces are indicated, they are not specific, and it is therefore not clear which movement of the Vivaldi or the Ligeti, or which of Chopin's waltzes, is referred to, making the study difficult to replicate exactly. As well as being randomised to a mood induction condition, participants were also randomised to either the catastrophising interview procedure (as mentioned above), or a reverse catastrophising interviewing procedure, where participants were asked to answer questions about something positive, creating six groups.

As in Johnston and Davey's (1997) study, the mood induction procedure referred to either positive, negative, or neutral affect, rather than specific emotional states. The authors reported that, in the pilot study, the negative music was described as "eerie", "mysterious", "spiritual", "relaxing", and "morbid"; the positive music as "exciting", "jolly", "dynamic", and "racy", and the neutral music as "calming" and "monotonous". The terms "relaxing" and "calming" generally refer to a positive affective state. However, the group randomised to negative music did have significantly higher self-reported negative affect after mood induction ($p < .05$) than the neutral or positive groups. The negative group also reported significantly lower happiness after the mood induction ($p < .05$), but no difference was found between postinduction ratings of happiness for the neutral or positive conditions. There was no significant difference between groups on either rating prior to the mood induction. This suggests that the negative mood induction was successful, and distinguishable from both neutral and positive groups, but that positive and neutral inductions could not be distinguished from each other.

Results showed that participants in the negative condition took significantly more steps in both the catastrophising and the reverse catastrophising interviews ($p < .001$). This suggested that negative mood was a perpetuating mechanism in both positive and negative perseverative thought.

This was explored further in a second experiment (reported in the same article), by considering how stop rules – which define how an individual decides to stop engaging in perseverative thought – affected this interaction between mood and perseveration. Participants (n = 120) were randomised to one of two stop rules: either "as many as can" (AMA), where participants are encouraged to keep persevering until they have explored every possible option, or "feel like continuing" (FL), where participants are told to keep persevering for as long as they felt like it.

Within these stop rules, participants were assigned to either a positively-valenced or a negatively-valenced brainstorming task, involving listing either good or bad (respectively) reactions to a scenario. These scenarios were predefined and as such had less personal salience and relevance than if they had been chosen by each individual participant.

Startup and Davey found that, when in the negative task, people took more steps with the AMA stop rule, and with the positive task, people took more steps with the FL stop rule.

It has been suggested that people who typically engage in worry (such as those with GAD) are more likely to naturally apply an AMA stop rule during perseverative thought (Davey, Startup, Zara, MacDonald, & Field, 2003; Meeten & Davey, 2012; Startup & Davey, 2001). It follows that negative mood is a core problem for individuals with GAD and contributes to the maintenance of pathological worry. Indeed, results from this experiment showed that, for participants applying an AMA stop rule, those classed as 'high worriers' (as per the Penn State Worry Questionnaire) took significantly more steps than low worriers (*p* < .005), and spent more time doing the task (*p* < .001).

Meeten and Davey (2012) extended the work of Startup and Davey in their bid to explore whether different emotions of the same valence have different or similar effects on the perseveration of worry. They hypothesised that, as in Startup and Davey's study, negative mood paired with AMA; and positive mood paired with FL would be associated with most perseveration, in comparison with the other pairings (negative mood and FL; positive mood and AMA).

In their study, participants (n = 150) watched a film clip as a means of mood induction. Films had been chosen via a pilot study to specifically induce either sad, happy, anxious, angry, or neutral mood. They then completed a catastrophising interview, where participants specified their own initial worry. For this task, participants were told either to use AMA or FL stop rules, based on randomisation, although participants were not informed that stop rule was an experimental variable.

Results showed that participants assigned to the happy mood induction had significantly greater perseveration when using FL stop rules as compared with AMA (*p* = .03), and that participants assigned to the negative mood inductions had significantly greater perseveration for when using AMA stop rules compared with FL (sad: *p* = .03; anxious: *p* = .003; angry: *p* = .03). Also, for the AMA stop rule, all negative emotions (apart from anger) resulted in significantly greater steps than the neutral emotional condition (sad: *p* = .03; anxious: *p* = .02; angry: *p* = .17). Similarly, for the FL stop rule, those assigned to the positive mood induction took significantly greater steps than those in the neutral condition (*p* = .005).

These results support the concept that negatively valenced affect has an effect on perseveration, when paired with an AMA stop rule, and that specific negative mood states are less important than the general negative affect. As such, for anxiety disorders (where a negative mood state, anxiety, is central) the pairing with as many as can stop rules, which may come naturally to some with anxiety disorders, can result in increased perseveration.

The findings from these studies show that negative affect is a core mechanism in the perseverance of worry. As such, addressing this negative affect could reduce worry, and improve treatment for anxiety disorders (Davey, 2006b).

It should be noted that this manipulation of affect could also be considered a safety behaviour, and indeed research on the emotional processing of fear would suggest that it is important to experience the negative affect associated with the trigger situation to promote extinction of fear (Foa & Kozak, 1986). However, as previously discussed, research on safety behaviours is currently inconclusive, and does not provide a strong case for removing safety behaviours indiscriminately.

Furthermore, music listening could reap benefits in the treatment of anxiety disorders. With its ability to modify affect and physiological arousal, music listening could function as a relaxation technique with the added ability of reducing perseverative thought. This could be particularly useful in severe cases, where exposure is otherwise unacceptable to the individual, or within cognitive restructuring, where alternative, positive interpretations of anxiety-provoking situations are sought.

2.2 Music and emotion

The previous section proposed two mechanisms via which music listening could be beneficial for the treatment of anxiety disorders: the reduction of physiological arousal and the facilitation of positive affect. This section of the literature review explores the research surrounding music's capacity to promote these emotional responses in the listener. Studies have found that different musical features[4] have been associated with different emotional responses in the listener, via both

[4] The term 'musical features' is used to refer to the auditory components of the music, rather than to individual experiences associated with the music.

physiological and self-report data. As such, the main aim of this section is to identify which musical features have been associated with optimal responses for reducing anxiety (i.e. decreasing physiological arousal and promoting positive affect). The findings from this literature review inform the choice of stimulus used in the experimental work reported in this thesis.

First, as proposed by Gabrielsson (2002), a distinction should be made between emotional perception, where an emotion may be detected within music without necessarily provoking an emotional response in the listener, and emotional induction, where the listener experiences emotional reactions in response to the music.

Within music psychology, there has been some debate as to whether the latter is possible. Indeed, Kivy (1990) classed himself as a 'cognitivist', someone who argues that music could not induce the same emotions that are perceived in, or expressed by, the music (in contrast to an 'emotivist', who does believe that music can induce emotions in this way).

Krumhansl (1997) investigated the 'cognitivist' and 'emotivist' debate by measuring psychological and physiological changes during music listening in two parallel experiments. In a 'dynamic rating' experiment, participants (n = 40) listened to six musical excerpts, and were randomised to continuously rate either sadness, fear, happiness, or tension (dependent on condition) on a slider. They also completed a mood questionnaire after each excerpt, which included rating scales from 0 to 8 for various mood adjectives (afraid, amused, angry, anxious, contemptuous, contented, disgusted, embarrassed, happy, interested, relieved, sad, and surprised), as well as pleasantness and intensity of and their familiarity with the music.

In the physiological experiment, participants (n = 38) listened to the same six musical excerpts, while continuous measures were taken of cardiac interbeat interval, pulse transmission time to finger, finger pulse amplitude, pulse transmission time to ear, respiration intercycle interval, respiration depth, respiration-sinus asynchrony, systolic blood pressure, diastolic blood pressure, mean arterial pressure, skin conductance, and finger temperature. They also completed the mood questionnaire after each excerpt.

In both experiments, the musical excerpts were 1) ‘Mars’ from *The Planets*, by Gustav Holst; 2) ‘Spring’ from *The Four Seasons*, by Antonio Vivaldi; 3) *Adagio* in G Minor for Strings and Orchestra, by Tomaso Albinoni; 4) *Night on Bare Mountain,* by Modest Mussorgsky; 5) *Adagio* for Strings by Samuel Barber; and 6) *Midsommarvaka,* by Hugo Alfven. Recording details were also given. These excerpts can be separated into emotional pairs: The Albinoni and Barber tracks were chosen to display ‘sad’ stimuli, the Holst and Mussorgsky to display ‘fear’, and the Vivaldi and Alfven for ‘happiness’.

Questionnaire results showed high interexperiment correlations for the excerpts (all greater than $r = .97$, $p < .0001$). Matched pairs had high correlations (sad: $r = .97$; fear: $r = .95$; happy: $r = .06$; all: $p < .0001$).

For the dynamic ratings, analyses of variance showed that ratings of the intended emotion were significantly higher than for unintended emotions, and that there was a significant main effect for excerpt type ($p < .0001$).

For the physiological ratings, change scores from baseline were calculated. Physiological results differed depending on intended emotion (sadness, fear, or happiness). The largest differences in interbeat interval, blood pressure, and skin conductance were seen for the sad excerpts, the largest differences in pulse transmission time and amplitude were seen for the fear excerpts, and the largest differences in respiration intercycle interval changes were seen for the fear and happy excerpts. All measures were significantly different between excerpt types apart from respiration-sinus asynchrony.

Correlations between physiological measures and dynamic ratings were very similar to the previous analysis, showing that correlations between physiological arousal and mood ratings were congruent with the type of excerpt.

Combined, the results suggest that psychophysiological measures can depict musical emotions, that different physiological responses were associated with different mood states, and, indeed, that musical emotions can be induced, rather than just perceived by listeners.

Since this article, an increasing amount of music and emotion research has provided strong support for the concept that music can indeed evoke emotional responses in the listener, rendering the cognitivist position continually weaker. Of particular relevance is the research exploring how musical features can be associated with differing physiological and affective states. These studies will be considered in Section 2.2.3.

2.2.1 Mechanisms of musical emotion induction

Despite the increasing amount of work on which musical features can induce differing emotional responses, why music can have these effects is a largely unexplored question.

Cognitive appraisal, a process where an individual "assesses the personal significance of an event for its well-being on a number of criteria and dimensions" (Scherer & Zentner, 2001, p. 366), is considered a central mechanism behind non-musical emotion induction (Scherer, Schorr, & Johnstone, 2001). Within the context of anxiety disorders, cognitive appraisal mechanisms have been implicated in the attentional bias to threat experienced by those with anxiety disorders, in the form of systems which detect, assess, and orient attention towards threat, as discussed in Section 2.1.2. In that context, it is the anxious individual's interpretation of the level of threat that facilitates their fear response, rather than the level of potential danger itself.

Although cognitive appraisal can be relevant to musical emotion induction in cases where the musical stimulus is relevant for goals or concerns (Juslin & Lindstrom, 2010), it is not considered the sole, or even a particularly frequent, mechanism, because musical emotions are not always directly associated to a personal goal.

In a landmark article, Juslin and Västfjäll (2008) introduced a collection of potential mechanisms behind musical emotion induction to be considered alongside cognitive appraisal. These mechanisms are not unique to, but are particularly relevant to, musical emotion induction. In addition, they do not necessarily occur in isolation; multiple mechanisms can interact to result in a complex emotional reaction.

Juslin and Västfjäll originally proposed six mechanisms: *B*rain stem reflexes, *E*valuative conditioning, emotional *C*ontagion, *V*isual imagery, *E*pisodic memory, and *M*usical expectancy (2008). Since then, two more mechanisms: *R*hythmic entrainment (Juslin, Liljestrom, Vastfjall, & Lundqvist, 2010), and *A*esthetic judgement (Juslin, 2013a), have been proposed, resulting in the acronym 'BRECVEMA' (with rhythmic entrainment coming before 'evaluative conditioning' in the acronym).

These mechanisms can be separated broadly into those which rely heavily on personal experiences of and preferences for music, and those which are posited to have more generalisable effects. The more personal mechanisms include evaluative conditioning and episodic memory, which both refer to personal associations between music listening and external events or stimuli; and aesthetic judgement, which refers to subjective evaluations of the music. More generalisable mechanisms include rhythmic entrainment, which refers to the concept of processes within the listener's body (such as heart rate or respiration rate) beginning to match, or entrain to, the beat of the music; visual imagery, which describes a process whereby the listener may experience mental images in response to the music; and musical expectancy, which relies on syntax and structure, and relates to the listener's previous experience of the musical style in question. This experience is likely to depend on the individual's cultural experience with music, but should work fairly reliably within a Western background. The expectancy mechanism is based on work by Meyer (1956), who proposed that emotions are evoked in a listener based on whether music confirms, delays, or violates the listener's expectations of how the music will progress. These mechanisms are posited to have a low induction speed.

It is the more generalisable mechanisms with high induction speed, namely brain stem reflexes and emotional contagion, that are of particular relevance to this thesis. A high induction speed enables the effects of music listening to be elicited in the context of a quick, accessible tool, either within the context of exposure therapy or worry reduction. As for the focus on these generalisable mechanisms, musical stimuli focusing on more personal mechanisms (sometimes referred to as ‘preferred’ music) tend to be chosen by the participants (see Section 2.3.2.2.1.1) as it would be difficult for experimenters to know which musical stimuli would activate these mechanisms without conferring with participants. In itself, conferring with participants draws attention to the use of music within an experimental situation, potentially confounding results. In comparison, musical stimuli focusing on more generalisable mechanisms are generally chosen by the researcher, or another expert. This allows for music to be incorporated into an experimental setting without drawing attention to the importance of music within the experiment.

The decision to focus on generalisable mechanisms behind music emotion elicitation is based on the wish to investigate the effects of music in as controlled a means as possible. Although reactions to music are impossible to control fully, as individuals’ responses to the same piece will differ, stimuli based on the more generalisable mechanisms with high induction speed provide a more consistent and controlled means of eliciting a specific emotion in a large group of people, and as such are of particular relevance to the issue of finding a stimulus to promote positive affect and reduced physiological arousal.

The conceptualisation presented in this thesis is centred around the brain stem reflexes and emotion contagion mechanisms. These mechanisms are now introduced in more detail, and linked to how they can inform stimulus selection.

The brain stem reflexes mechanism is of some relevance, as it provides some insight into which musical features should be avoided so as not to provoke sudden increases in arousal. Brain stem reflexes are posited to occur automatically, without conscious, cognitive appraisal. The brain stem is composed of the midbrain and hindbrain (the latter of which consists of the pons and the medulla), and is involved in arousal, changes in cardiac and respiratory activity, and relaying auditory information (Bear, Connors, & Paradiso, 2007). As such, the brain stem reflexes mechanism is particularly relevant to how music can effect changes in arousal. This mechanism refers to how the brain stem, representing the ancient part of the brain, is constantly scanning the environment for changes. As such, within the context of music, sounds that represent the need to react urgently can activate the brain stem, including music that is quick, loud, dissonant, and that has sudden sounds (Juslin & Västfjäll, 2008).

According to the brain stem reflex mechanism, music which is loud, quick, and dissonant, with sudden changes is likely to increase arousal. As such, these musical features should be avoided when selecting a stimulus to reduce anxiety, to avoid evoking an automatic threat response.

The emotional contagion mechanism is of more relevance to this thesis, as it provides a possible explanation for how musical features can be associated with different emotional responses. In a musical context, emotional contagion posits that a listener interprets an emotion from the music, and that this emotion is then induced internally. This has been dubbed an “iconic relationship” (Sloboda & Juslin, 2001).

Emotional contagion research has been conducted in non-musical contexts. Hatfield and colleagues (Hatfield, Rapson, & Le, 2011) proposed three possible, interlinking mechanisms which explain how emotions can be caught via contagion: 1) mimicry, where people automatically mimic the expressions of others; 2) feedback, where people’s emotional experience is altered by feedback from the mimicry; and 3) contagion, where people catch the emotions of others.

It is within the domain of speech that we see a link with musical emotional contagion. Studies have suggested that emotional contagion exists with speech, and research has shown that emotional cues within speech and music are similar. Combining this research leads to the possibility that listening to music can be a conduit for emotional contagion.

Firstly, Neumann and Strack (2000) investigated the presence of nonintentional emotional contagion within speech. In a first experiment, participants (n = 30) were asked to listen to a philosophical speech that was either recited in a happy, sad, or neutral voice, depending on randomisation. Participants were naïve to the intentional emotional element of the recitation. After the recitation, participants completed a questionnaire asking for their mood state (on 10-point scales for each of cheerful, happy, angry, anxious, sad, and bored). Results showed that mood was affected by exposure to the speech ($p < .01$). Those in the happy condition reported more positive mood states than those in the negative condition ($p < .004$). However, no significant effects were found for any of the specific adjectives. These results suggest that nonintentional emotional contagion exists within the domain of speech, regarding positivity and negativity, but not necessarily for specific emotional states.

In a second experiment, reported in the same article, Neumann and Strack explored whether perceiving vocal cues could elicit action codes. Participants (n = 44) listened to either a happy or sad version of the philosophical speech, and were asked to read aloud the speech while listening. Their recitation was recorded. Then, each participant-recited speech was played to another participant (from an independent sample, with each of these participants only hearing one recitation). The participants in this second half rated how strongly they thought the speaker felt happy, angry, anxious, sad, or aroused, on 10-point scales. Results showed that participants who had listened to and repeated the happy speech were rated as less sad and more happy than those who listened to and repeated the sad speech, although this was not quite significant ($p < .06$). Participants who repeated the sad speech were rated as more sad than those who repeated the happy speech ($p < .05$), and those who repeated the happy speech were rated as more happy than those who repeated the sad speech, although again this was not quite significant ($p < .06$). These results suggest that listening to someone speaking in a happy or sad way can elicit a similar vocal reaction in a listener. However, although participants were not asked to accurately recreate the emotion within speech, and the experimenters made attempts to mask the purpose of the task, it is possible that participants assumed that recreating the emotional expression of the speech was an element of the task.

These experiments showed that emotional vocal cues can both induce a congruent emotion in a listener, and that this listener may automatically reproduce the same emotion when repeating speech, suggesting the presence of emotional contagion.

Within a musical context, Juslin and Laukka (2003) compared the auditory performance cues of music and speech, and found that auditory, performance cues were associated with similar perceived emotions in speech and music. As such, it is possible that emotional contagion functions within a musical context because music reminds us of an expressive voice. Indeed, because music can go further than speech in terms of dynamic, speed, and intensity, it has been termed a “super-expressive voice” (Juslin, 2001).

It has been posited that emotional contagion is a mechanism which links perceived emotion within music and induction of that emotion. Egermann and McAdams (2013) examined the roles of empathy and emotional contagion in linking recognised (or perceived) and felt (or induced) emotions. They conducted a web-based experiment (framed as an online personality test), where participants (n = 3164) completed questions in response to five (of a possible 23) musical excerpts (each 30 seconds long). Participants were randomised to give either perceived or felt ratings of each stimulus on visual analogue scales for arousal and valence, as well as empathy with musicians, familiarity, and preference. As hypothesised, results showed that participants giving perceived ratings of arousal and valence rated the stimuli significantly differently to those giving felt ratings ($p < .001$). However, controlling for empathy ratings reduced this gap somewhat.

The authors looked for the presence of emotional contagion by running statistical analyses to explore the nonmoderated effects of emotional expression on ratings of felt emotion. They found an independent main effect of emotional expression on felt emotion, suggesting that emotional contagion was present. This link between emotional expression of the music and felt emotion by the listener provides a potential explanation for how different musical features can be associated with differing emotional responses.

In a recent study, Juslin, Harmat, and Eerola (2014) used a listening experiment to investigate four of the BRECVEMA mechanisms: brain stem reflex, emotional contagion, episodic memory, and musical expectancy. A piece of music ('Prayer' from *Jewish Life*, by Ernest Bloch) was altered, with the intention of activating one of these mechanisms in each version.

Activation of the brain stem reflex was promoted by adding a sudden, loud chord into the piece, and was expected to be associated with surprise. Emotional contagion was promoted by using a cello performance with a sad expression, based on the premise that sad performances are most expressive, and this version was expected to be associated with sadness. Episodic memory was promoted by unobtrusively integrating a well-known theme from the movie *Star Wars* into the piece, and this was designed to elicit nostalgia and happiness. Musical expectancy was manipulated by violating expectations, both harmonically and melodically, and this was expected to elicit anxiety and irritation.

Participants ($n = 20$) listened to all versions in a randomised order. Subjective emotions were measured using a music-specific measure, and further questions were used to assess the extent to each mechanism was activated. Physiological measures included pulse rate, facial electromyography (EMG), and skin conductance.

Results for subjective emotion showed that the episodic memory version was associated with a significantly higher happiness rating than the other versions; the emotional contagion version with a significantly higher sadness rating, and the brain stem reflex version with a significantly higher surprise rating. The musical expectancy version was rated as significantly more irritating and more anxiety-provoking than the episodic memory version, and the episodic memory version as inducing significantly more nostalgia than the brain stem reflex and musical expectancy versions.

A significant effect of mechanism was found for skin conductance and EMG (both $p < .001$). Skin conductance was significantly lower during baseline than while listening to the brain stem reflex ($p < .0001$), episodic memory ($p < .05$), or musical expectancy ($p < .05$) versions, with the brain stem reflex version being associated with the highest skin conductance level. EMG data showed that versions designed to elicit negative emotions were associated with little muscle activity, and those designed to elicit positive emotions were associated with more muscle activity, meeting predictions. Only the brain stem reflex version was associated with a significant change from baseline ($p < .05$).

Results from this study suggested that the target mechanisms, and for the most part the target emotions, were indeed activated. It is important to remember mechanisms are contextual, and as such that this study does not suggest that emotional contagion is only responsible for sadness, or that episodic memory is only responsible for nostalgia.

It is important to bear in mind that research on the mechanisms behind musical emotion induction is still in its infancy, and all mechanisms posited by Juslin and colleagues are hypotheses, currently with relatively little empirical research examining them. This thesis does not aim to test these mechanisms, rather to use them as a lens through which to conceptualise music listening's capacity to be part of treatment for anxiety disorders. These mechanisms do provide some insight into potential explanations for the increasing amount of evidence suggesting that specific musical features can be linked to differing emotional responses. This evidence will now be considered, with the aim of investigating which musical features have been associated with reducing physiological arousal and promoting positive affect, or valence. Again, this research will not be tested specifically in this thesis. Rather, the findings from these studies will be used to create criteria for selecting optimal stimuli for a study examining music listening in a situation analogous to an anxiety disorder.

Before examining the literature investigating which musical features are associated with different emotional reactions, the models used to define these emotions will be considered.

2.2.2 Models of emotion

Within music and emotion studies, there are two dominant models of (or means of categorising) emotions: the discrete model and the dimensional model. Most music and emotion studies use one of these two models.

The discrete model is based on the idea that all emotions come from a finite group of emotions (Eerola & Vuoskoski, 2013). The most commonly-used discrete model is the basic emotion model, comprising emotional states such as happiness, sadness, anger, fear, and disgust (Ekman, 1992). Although it is possible to imagine feeling happiness, sadness, anger, or fear in response to music, it is harder to imagine feeling disgusted in response to musical features.[5] As such, music and emotion studies often modify this set. In some cases, only one emotion is changed, such as replacing disgust with a more music-appropriate adjective, such as tenderness (as in Eerola & Vuoskoski, 2011). However, many studies using the discrete model make more substantial changes, resulting in a range of studies which are not measuring the same thing (Eerola & Vuoskoski, 2013). This makes it more difficult to extrapolate general findings from the literature than if we had a large body of literature all exploring musical features involved in the same set of emotions.

Juslin (2013b) argued that, although basic emotions are particularly relevant to the expression of musical emotions, induction, or arousal, of musical emotions is not restricted to this approach. Basic emotion terms, such as happiness and sadness, are usually easily understood by participants, increasing rating ease, but the use of specific categories can be restrictive, only allowing participants to choose from a pre-defined set of emotions.

The dimensional model places all emotions in an affective space comprised of multiple axes. The most commonly-used dimensional model is the circumplex model of affect (Russell, 1980; Russell & Barrett, 1999), which has one axis for arousal

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[5] Disgust may be elicited if, due to evaluative conditioning or episodic memory, we associate the music with a previous situation which caused us to feel disgusted.

(how much energy is felt, from activated to deactivated) and one axis for valence (from positive to negative, or pleasant to unpleasant). Thayer proposed an alternative dimensional model (1989), with axes for energetic arousal and tense arousal, which has been less frequently used in music and emotion studies.

Eerola and Vuoskoski compared perceived (expressed) ratings of film music excerpts using discrete and dimensional models (2011). In their study, participants (n = 116), were asked to rate these excerpts (110 total) in two blocks. In one block, they rated each excerpt for the presence of discrete emotions (happiness, sadness, fear, anger, and tenderness) from 1 to 9. In the other block, participants rated the excerpts from 1 to 9 for three axes of a dimensional model (valence, energy, and tension, chosen to incorporate both Russell and Thayer's models, and therefore to explore which axes were most important). The blocks were counterbalanced between participants.

Results showed that the discrete and dimensional models were highly correlated, and that discrete ratings could thus be used to predict dimensional ratings (around 90% of the time) and vice versa (around 80% of the time). Eerola and Vuoskoski also found that there was no clear difference between the accuracy of the two-dimensional models.

In sum, this study showed that emotions can accurately be perceived via multiple emotional models, and that these perceived emotions can be predicted between models. However, we should keep in mind that this result may not be replicated in induced emotions, although emotional contagion remains a possible link between the two.

Which of these approaches is better suited to exploring listening to music in the context of anxiety? Emotional contagion provides a link between perceived and induced emotions. If basic emotions are particularly relevant to perceived emotions, then does this mean that, via emotional contagion, basic emotions are the most appropriate way to categorise emotions? Juslin and Västfjäll (2008) suggest that emotional contagion is most suited to inducing basic emotions. But there is no basic emotion that accurately matches the state we are trying to induce (i.e. increased positive affect and decreased physiological arousal). Indeed, specific emotional adjectives (such as happiness or sadness) are not germane to this thesis. In contrast, the circumplex model of affect is of great relevance to this thesis. The two axes can clearly represent the ways in which music listening can impact on the physiological arousal (arousal) and cognitive (valence) aspects of an anxiety disorder, mirroring the two proposed utilities of music listening in this thesis: to reduce physiological arousal, and to promote positive affect, thus reducing perseverative thought such as worry.

Within the dimensional model, emotions can fall into one of four possible quadrants (see Figure 2.1): high arousal, negative valence (which relates to anxiety), high arousal, positive valence (happiness), low arousal, negative valence (sadness/depression), and low arousal, positive valence (relaxation). It is therefore easy to classify the necessary quadrant for different functions of music. For the purposes of this thesis, we are looking for music that is associated with positive valence and low arousal, and therefore can promote relaxation and combat anxiety.

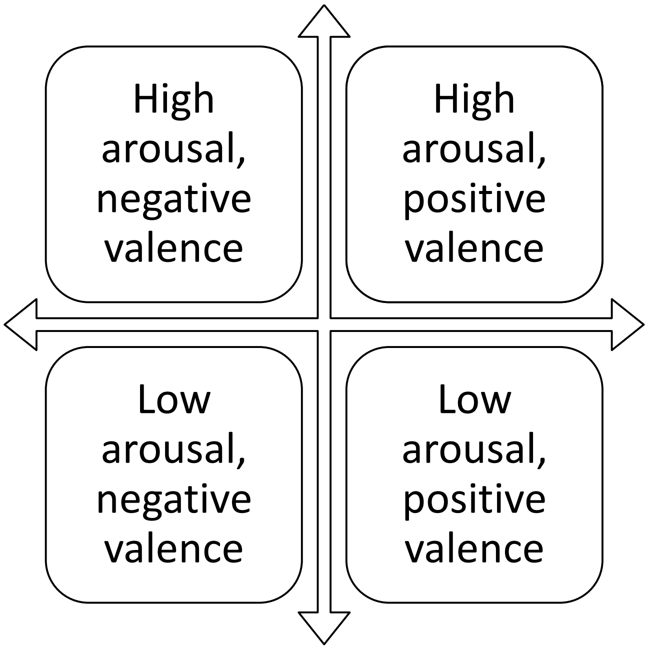

Figure 2.1: Four quadrants of the circumplex model of affect

2.2.3 Musical characteristics and emotion induction

A number of studies have examined what musical features can be associated with the parameters of positive valence and low arousal. Presented here are the studies that were used to create criteria for subsequent stimulus section. This will focus on compositional features of the music, rather than those that are specifically modified by the performer, and induced, rather than perceived emotions, since we are aiming to induce an affective state in the listener as a means of reducing anxiety. First, studies that explore physiological measures alone will be reported, followed by those that consider both induced arousal and valence.

2.2.3.1 Arousal

Copeman, Fink, and Costello (2005) explored the role of tempo in modulating heart rate, hypothesising that listening to slow music could lower heart rate. Their study used fast music, slow music, and no music conditions, with each of the participants (n = 37) experiencing one of six orders of these conditions. The fast music used was Beethoven's *Piano Sonata No 14 in C sharp minor* (168 bpm), and the slow music was track 2 from Quitmeyer and Wesley's *Musical Journeys* (60 bpm). After an initial 10 minute habituation period, each excerpt lasted four minutes, and was followed by a rest period of equal duration.

A general linear model repeated measures (GLM-RM) procedure found that listening to specific slow music was correlated with a lower heart rate more than listening to specific fast music (p = .007) and listening to no music (p = .000). Although this supports the hypothesis that slow music can lower heart rate more than fast music, it is likely that the opposing tempos were not the only contrasting features within the music, and therefore the tempo may not have been responsible for this difference.

Iwanaga, Kobayashi, and Kawasaki (2005) measured heart rate variability in response to repetitive exposure to "sedative" or "excitative" music. They hypothesised that repeated listening to sedative music would increase high frequency heart rate variability (HRV), which correlates with increased subjective relaxation.

Their study (n = 13) used “sedative” music (Satie’s *Gymnopédie No.1*, arr. Debussy), “excitative” music (Stravinsky’s ‘Sacrificial Dance’ from *The Rite of Spring*), and no music, as the three interventions. Their study had a within subjects design, meaning that all participants experienced all conditions, in varying orders. However, each participant only experienced one intervention condition each day, returning between two and four days later for the next condition. The order was counterbalanced between participants.

Gymnopédie was described as being “melodious, delicate, soft, and beautiful”, and ‘Sacrificial Dance’ as “dynamic, rhythmic, and wild, performed fiercely with brass and percussion instruments” (p. 62). The recordings used were also specified, but no further information was given on the musical features. Both conditions lasted 300 seconds (275 seconds of music and 25 seconds of quiet rest). The no music intervention consisted of 300 seconds of quiet rest. After each condition, the subjects completed seven-point scales for subjective relaxation and tension (from very little to very much). Heart rate was measured throughout.

A two-way ANOVA showed that sedative music and no music conditions yielded significantly greater perceived relaxation than excitative music ($p < .001$). Heart rate was lower in sedative music and no music conditions than in the excitative music condition, but this was not significant. However, the high frequency component of HRV was increased in sedative music as opposed to excitative music ($p < .05$). Although these results do not show that sedative music necessarily reduces physiological arousal more than quiet rest, they do indicate that music has the ability to modulate perceived relaxation and autonomic arousal, as can be seen in the differing results of sedative music and excitative music.

Another variable from this study was repetition, with each participant undergoing each condition four times. Heart rate was significantly correlated with repetition, with increased repetition linked with decreased heart rate ($p < .001$) in all conditions. This suggests that repeating a musical stimulus can decrease physiological arousal.

The results from this study highlight the importance of prudent selection of the musical stimulus. However, as specific musical features were not reported in this study, we cannot know what in particular led the experimenters to categorise the stimuli as “excitative” or “sedative”. *Gymnopédie* is slow, quiet, in a minor key, with simple rhythms, a moderate amount of dissonance, and a clear melody; ‘Sacrificial Dance’ is fast, loud, and atonal, with complex rhythms, a lot of dissonance, and no clear melody. Both stimuli used in the study were orchestral versions (*Gymnopédie* was originally written for piano). Considering that both stimuli contained at least moderate levels of dissonance, and were either minor or atonal, it seems that tempo, loudness, simplicity of rhythm, and clarity of melody could be responsible for the differential responses.

Although the studies mentioned in this section do include measures of perceived relaxation, they have not been explicitly linked to specific musical features, other than tempo. The follow section examines the correlation between musical structure, arousal, and valence, and thus begins to uncover what music is most likely to reduce physiological and psychological components of anxiety.

2.2.3.2 Valence and arousal

Husain and colleagues (2002) explored the effects of tempo and mode on felt arousal and valence, which they call mood.[6] Participants (n = 36) listened for ten minutes to one of four versions of a Mozart sonata (*K. 448*, movement 1), which had been manipulated to have either fast (165 bpm) or slow (60 bpm) tempo and either major (D major) or minor (D minor) mode.

Arousal and mood were measured in a number of ways. First, by using the revised version of the Profile of Mood States (POMS), short form (McNair, Lorr, & Droppleman, 1992), both before and after listening to the music. Of particular interest were the vigor-activity [sic] subscale for denoting high arousal, and depression-dejection for negative mood. Second, by explicitly rating arousal (from

[6] This use of mood seems akin to valence. Indeed, the authors use the two in combination at some points.

extremely low to extremely high) and mood (from extremely unpleasant to extremely pleasant) on a grid akin to the circumplex model of affect, dubbed an 'affect grid'. Thirdly, by using a subjective 7-point scale of high-energy to low-energy, which was expected to correlate with both arousal and mood.

Difference scores were calculated by subtracting premusic scores from postmusic scores. Then principal components analysis was used to reduce these scores to two: one for arousal, and one for mood (valence). The vigor-activity subscale and the arousal scale from the affect grid loaded onto arousal. The depression-dejection subscale and the mood scale from the affect grid loaded onto mood. The subjective 7-point scale loaded onto both.

As hypothesised, two-way ANOVAs using the factor scores showed that fast tempo was associated with increased arousal ($p < .001$), but no significant changes in mood. Conversely, major mode was associated with increased mood ($p < .001$) but no significant changes in arousal. This suggests that, to reduce physiological arousal and promote positive affect, slow, major music might be effective.

Gomez and Danuser (2007) aimed to pinpoint specific structural components of pleasant (positive valence) and arousing music. They based the musical features included in their study on previous work by Gabrielsson and Lindstrom (2003). Eleven features were included (tempo, rhythm, accentuation, rhythmic articulation, pitch level, pitch range, melodic direction, mode, harmonic complexity, consonance, and sound intensity), all of which were rated prior to the experiment by music experts, bar the latter which was manipulated electronically. Gomez and Danuser's study had 31 participants, none of whom specified a dislike of classical music, as per a questionnaire. Participants rated their own experiences of arousal and valence in response to 32 excerpts of sound and music, using the 9-point Self-Assessment Manikin (M. M. Bradley & Lang, 1994). Respiration rate, heart rate, and skin conductance were also measured.

Gomez and Danuser identified significant correlations between musical features and either felt arousal or valence as per a general linear model. Although some features fell clearly within a specific quadrant (i.e. low arousal and positive valence), some applied only to valence or arousal individually, meaning that some conflicts are possible. For example, a faster tempo was linked to both increased positive valence and increased arousal. This means that when considering a low arousal positive valence stimulus, a decision must be made as to whether to honour tempo's role in valence or in arousal. This is also the case for staccato articulation, which was associated with both positive valence and high arousal. Both tempo and articulation were found to have a higher regression coefficient for arousal than with valence (tempo: valence coefficient = 0.10, $p < .01$, arousal coefficient = 0.43, $p < .00001$; articulation: valence coefficient = -.26, $p < .001$; arousal coefficient = -0.33, $p < .0001$), As such it seems that tempo and articulation had more effect on arousal than valence.

However, there were a number of features that could be clearly allocated to a specific quadrant. As such, structural features correlated with low arousal, positive valence ratings included low sound intensity (quiet dynamic), clear rhythm, major mode, simple harmony, and consonance. In contrast, high arousal, negative valence ratings were linked with high sound intensity, vague rhythm, minor mode, complex harmony, and dissonance. Increased skin conductance was associated with a faster tempo ($p < .00001$), accentuation ($p < .001$), and staccato articulation ($p < .01$), and increased heart rate with a faster tempo ($p < .05$).

As such we can start to build an idea of what music could be used as a stimulus for promoting positive affect and decreased phyisological arousal. As high tempo and staccato articulation were associated with increased physiological arousal, low tempo and legato articulation will be chosen to elicit low arousal, rather than high tempo and staccato articulation for positive valence. This agrees with the view that rhythm is particularly correlated with arousal because of its role in our everyday life (e.g. faster walking is linked with increased arousal), and could relate to the concept of "iconic relationships" (Sloboda & Juslin, 2001), on which the emotional contagion mechanism is based. Positive valence will be modulated by more harmonic aspects, such as mode and consonance, which are more dependent on culture and experience.

Coutinho and Cangelosi (2011) built upon Gomez and Danuser's work, and measured how musical features correlate with the dimensions of arousal and valence. In particular, they posed that affect was more influenced by low-level musical structural features than anything else (such as loudness and tempo), and as such chose not to monitor more culturally-dependent features such as melody and harmony. They allowed the participants (n = 39) to categorise the felt dimensional emotions of the music in real-time, using EmuJoy software (Nagel, Kopiez, Grewe, & Altenmuller, 2007) to pinpoint the music's place within the circumplex model of affect throughout the experiment. Their results showed that increased subjective arousal was linked to increased loudness ($r = .60, p < .001$), tempo ($r = .67, p < .001$), pitch ($r = .52, p < .001$), and sharpness ($r = .63, p < .001$), and that more positive valence was linked with faster tempo ($r = .54, p < .001$) and higher pitch level ($r = .41, p < .05$). Higher heart rate was correlated with higher perceived arousal ($r = .46, p < .05$), and also with louder excerpts ($r = .51, p < .05$).

As with Gomez and Danuser's (2007) study, valence and arousal were sometimes contradictory, especially regarding tempo and pitch (which correlated positively with both arousal and valence). As in Gomez and Danuser's study, tempo was correlated more strongly with arousal than with valence, as was pitch.

These studies give us some insight into which musical features can be correlated with low arousal and positive valence. From these, the following features were chosen as stimulus inclusion criteria for selecting an optimal stimulus to reduce physiological arousal and promote positive affect: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes (see Table 2.1).

Table 2.1: Stimulus inclusion criteria from literature

Criterion	References	Comment
Slow tempo	Copeman et al. (2005)	Associated with lower physiological arousal (as per heart rate)

	Coutinho and Cangelosi (2011)	Associated with lower subjective arousal, but also with more negative valence
	Gomez and Danuser (2007)	Associated with lower physiological arousal (as per heart rate and skin conductance) and lower subjective arousal. Also associated with increased negative valence, but the effect was greater for arousal than valence.
	Husain et. al (2002)	Associated with lower subjective arousal
	Juslin and colleagues (2008, 2010)	Hypothesised to reduce possibility for increased arousal via brain stem reflex
Major mode	Gomez and Danuser (2007)	Associated with lower subjective arousal and increased positive valence
	Husain et al. (2002)	Associated with increased positive valence
Clear rhythm	Gomez and Danuser (2007)	Associated with lower subjective arousal and increased positive valence
Quiet dynamic	Coutinho and Cangelosi (2011)	Associated with decreased subjective arousal and physiological arousal (as per heart rate)
	Gomez and Danuser (2007)	Associated with lower subjective arousal and increased positive valence

	Juslin and colleagues (2008; 2010)	Hypothesised to reduce possibility for increased arousal via brain stem reflex
Simple harmony	Gomez and Danuser (2007)	Associated with lower subjective arousal and increased positive valence
Consonance	Gomez and Danuser (2007)	Associated with lower subjective arousal and increased positive valence
	Juslin and colleagues (2008; 2010)	Hypothesised to reduce possibility for increased arousal via brain stem reflex
Lack of accentuation	Gomez and Danuser (2007)	Associated with decreased physiological arousal (as per skin conductance)
Legato articulation	Gomez and Danuser (2007)	Associated with lower subjective arousal and physiological arousal (as per skin conductance). Also associated with increased negative valence, but the effect was greater for arousal than valence.
Lack of sudden changes	Juslin and colleagues (2008; 2010)	Hypothesised to reduce possibility for increased arousal via brain stem reflex

Despite (or possibly because of) the rapidly-increasing amount of research in the field of music and emotion, there are major inconsistencies in the field. There is currently no standardised approach to conducting this type of research, resulting in a heterogeneous body of research. In response to this situation, Eerola and Vuoskoski

(2013) conducted a review of 251 music and emotion studies. They found that music and emotion studies did not consistently measure the same thing: While some measured physiological responses, some used self-report measures, and others measured the association between musical features and emotional responses. Within studies measuring self-report responses, different models of emotion were used (see Section 2.2.2) making these studies difficult to compare.

There is particular inconsistency within studies exploring the musical features associated with specific emotions. The distinction between perceived (or expressed) and induced (or felt) emotion is not always clear. In addition, while some studies focus on features that are components of the composition, others consider only those elements that can be altered by the performer. This has led to a somewhat disjointed collection of features and associated emotions that cannot be considered comparable (see Figure 2.2). As we have seen, induced and perceived ratings are not always the same. This review has focused on compositional features and induced emotion.

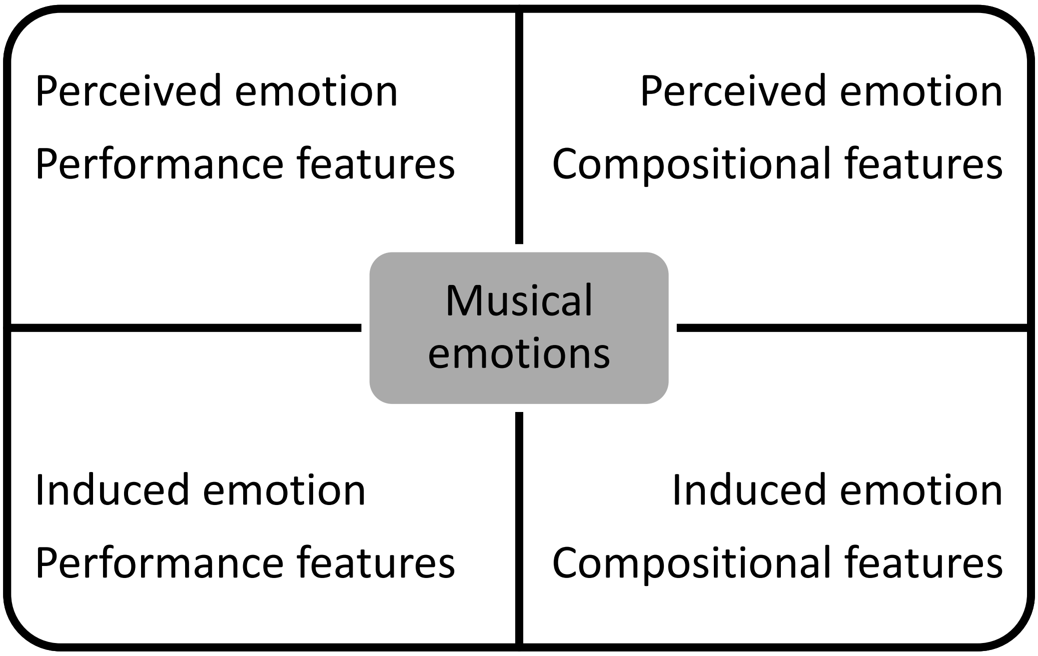

Figure 2.2: Matrix of music and emotion studies

These differences are not necessarily problematic in themselves. Indeed, they could be seen as a positive sign of a diverse and burgeoning field, which is exploring multiple avenues before developing into a more homogeneous, consistent base of knowledge. However, whatever methodological decisions made, future researchers should be transparent in their decision-making, being explicit about why they have chosen their emotional model, measures, and approach (Eerola & Vuoskoski, 2013).

Although not all studies explore the relationship between emotions and specific musical features, it would be helpful for researchers to justify their choice of stimulus, something that is not always done. This could be very useful for those considering the potential mechanisms behind emotional induction.

Indeed, the lack of attention paid to the potential mechanisms behind musical emotional induction could be related to the varied nature of the field. Researchers are looking for effects of music, but as a field we know little about the potential causes. To make progress, researchers should make their theoretical perspective clear, especially regarding the mechanisms behind musical emotional induction, and be transparent about stimulus decisions, to allow future researchers to consider this in relation to potential mechanisms.

2.2.4 Summary

This section has explored the research on music's capacity to evoke emotions, and thus to modulate both affect and physiological arousal. By reviewing the research exploring emotional responses to specific features, a set of criteria has been identified to be used in the selection of an optimal stimulus for promoting positive affect and reduced physiological arousal, and thus to reduce anxiety: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

In conjunction with the previous section, a theoretical rationale for music listening in the treatment of anxiety disorders is proposed: Via the mechanisms of emotional contagion and brain stem reflexes, specific musical features can manipulate arousal and valence, and this could counter physiological arousal and worry (the latter through evoking positive affect, as posed by the mood-as-input hypothesis), and thus be beneficial in the treatment of anxiety disorders.

The next section considers the current state of the evidence base for music listening as a treatment for anxiety (outwith an anxiety disorder setting), thus examining the foundation for work specifically modelling anxiety disorders.

2.3 Music and anxiety studies

Having proposed a theoretical rationale for the use of music listening in treating anxiety disorders in the previous two sections, this section discusses the current evidence base for music listening in the treatment of anxiety (outwith the context of anxiety disorders).

There are a large number of randomised control trials (RCTs) that have explored the effects of music listening in response to specific anxiety-provoking situations. These trials have taken place in a number of different health settings, with patients undergoing a wide variety of procedures, and are often based in hospitals. These RCTs have attempted to provide an evidence base for using music listening as a health intervention. Indeed, the majority of these RCTs have found that music listening resulted in significantly reduced subjective anxiety and physiological arousal in comparison with standard care in a variety of settings. Although these RCTs have not been conducted with a population with anxiety disorders and thus include elements of both pathological worry and physiological arousal, the findings provide an evidence-based rationale for the proposed benefits music listening could have within treatment for anxiety disorders.

It would not be feasible to report the findings from the hundreds of studies investigating music listening in addressing anxiety in health settings. Instead, four systematic reviews from the Cochrane Library will be discussed. Cochrane systematic reviews are considered an excellent means of assessing evidence for healthcare interventions. Following this, some of the most common limitations in music and anxiety studies will be reviewed.

2.3.1 Cochrane reviews

A number of Cochrane reviews have sought to quantify the quality and nature of the evidence for music's ability to reduce anxiety (Bradt & Dileo, 2009; Bradt, Dileo, & Grocke, 2010; Bradt, Dileo, Grocke, & Magill, 2011; Bradt, Dileo, & Shim, 2013). These reviews considered the effects of music for people with coronary heart disease (Bradt & Dileo, 2009), mechanically ventilated patients (Bradt et al., 2010), cancer patients (Bradt et al., 2011), and patients awaiting surgical procedures (Bradt et al., 2013).

These reviews were not restricted to music listening RCTs, rather being open to all music interventions (including passive techniques, such as music listening, and active interventions, such as music making). However, the majority of included studies used music listening, and as such the findings are relevant here.

These reviews have, to varying degrees, supported the idea that music interventions in general, and music listening in particular, can reduce self-report (or subjective) anxiety and physiological arousal. Despite these promising findings, the pooled results have often had high levels of heterogeneity, suggesting that different studies have found varying levels of benefits from music.

The first review (Bradt & Dileo, 2009) explored the effects of music on stress and anxiety in coronary heart patients. This review included 23 trials, all of which used music listening bar one, and which were published between 1987 and 2008.

The authors extracted information on the musical stimuli, and found that ten studies gave details about the music used (composer and piece name), while eleven only gave information about the styles from which subjects could choose (such as jazz, country and western, etc.). In fourteen studies, the patient could choose the music; in nine studies, the music was chosen by a researcher.

Bradt and Dileo (2009) found that music listening reduced self-reported anxiety in comparison with standard care (SMD = -0.49, p = .004), but these results were inconsistent between studies (χ^2 = 46.91, p < .00001, I^2 = 77%). Heterogeneity was reduced by running analyses specifically on studies using the state scale of Spielberger's State Trait Anxiety Inventory (STAI-S) to measure subjective anxiety and by grouping patients by type (myocardial infarction [MI]; surgical/procedural). This showed that music was particularly effective with MI patients compared with control (MD = -5.72, p < .00001), and results were much more consistent (χ^2 = 11.33, p = .08, I^2 = 47%). The same effect was not found for surgical/procedural patients (MD = 0, p = .47), possibly because anxiety dropped back to normal levels after the procedure in both experimental and control conditions. This supports the idea that music listening is most effective with persistent anxiety.

Analyses were also run comparing researcher-selected and patient-selected music for those studies which used the STAI-S to measure anxiety. Results showed that patient-selected music (where patients were encouraged to choose from a selection) was less effective in reducing anxiety (MD = -2.73, $p < .0001$; $\chi^2 = 31.83$, $p < .00001$, $I^2 = 87\%$) than researcher-selected music (MD = -5.16, $p < .00001$; $\chi^2 = 14.92$. $p = .005$, $I^2 = 73\%$).

Heart rate (MD = -3.92, $p = .009$) and respiratory rate (MD = -3.05, $p < .0001$) reduced in the music conditions in comparison with standard care, but results were inconsistent (heart rate: $\chi^2 = 57.92$, $p < .00001$, $I^2 = 78\%$; respiratory rate: $\chi^2 = 26.36$, $p < .00001$, $I^2 = 85$). Separate analyses by patient-selected versus researcher-selected music showed that researcher-selected music had a smaller, but more homogeneous effect (heart rate: MD = -2.74, $p = .006$; $\chi^2 = 2.89$, $p = .58$, $I^2 = 0\%$; respiratory rate: MD = -1.71, $p < .00001$; $\chi^2 = 0.55$, $p = .76$, $I^2 = 0\%$), whereas patient-selected music showed a bigger, but less consistent, effect (heart rate: MD = -6.44, $p < .00001$; $\chi^2 = 46.38$, $p < .00001$, $I^2 = 83\%$; respiratory rate: -6.72, $p = .06$; $\chi^2 = 12.18$, $p = .0005$, $I^2 = 92\%$).

This review demonstrated that music listening was effective at reducing subjective anxiety and physiological arousal (as per heart rate and respiratory rate). The subjective anxiety findings suggest that music listening could be most effective in situations where anxiety does not drop of its own accord. This could be particularly relevant to anxiety disorders, which are characterised by difficulty in regulating emotional responses (Cisler et al., 2014).

In the second review, Bradt, Dileo, and Grocke (2010) explored the effect of music interventions for mechanically ventilated patients. This review included 8 studies, 7 of which used music listening, and 1 of which used music therapy, published between 1995 and 2007. Of the music listening studies, only one used researcher-selected music; the others used patient-selected music.

Bradt, Dileo, and Grocke (2010) found that music (listening, as separate analyses were run for music listening) significantly reduced self-report state anxiety (SMD = -1.06, $p = .04$), but that this was not consistent across studies ($\chi^2 = 13.43$, $p = .001$, $I^2 = 85\%$). However, music listening consistently reduced heart rate (MD = -4.75, $p = .001$; $\chi^2 = 2.44$, $p = .66$, $I^2 = 0\%$) and respiratory rate (MD = -3.18, $p < .001$; $\chi^2 = 2.58$, $p = .76$, $I^2 = 0\%$) in comparison with standard care. This review demonstrated that music listening could be effective, but that this effect was not consistent between studies for state anxiety.

In the third review, Bradt, Dileo, Grocke, and Magill (2011) reviewed music interventions for improving psychological and physical outcomes in cancer patients. Their review included 30 studies, 13 using music therapy, and 17 using music listening, published between 1989 and 2010.

The authors found that music (listening or therapy) resulted in a greater reduction in state (or situational) anxiety scores (MD = -11.20, $p = .009$; $\chi^2 = 82.36$; $p < .00001$, $I^2 = 99\%$) in comparison with standard care. The authors commented that this inconsistency was related to some studies reporting much larger effects than others, rather than being due to the variation between effective and ineffective findings. The largest effects were found for two studies using music listening. Similar (but more consistent) effects were also found for heart rate (MD = -3.78, $p = .007$; $\chi^2 = 1.74$, $p = .63$, $I^2 = 0\%$) and respiratory rate (MD = -2.34, $p = .03$; $\chi^2 = 3.25$, $p = .07$, $I^2 = 69\%$). This review suggested that music listening could be effective for reducing subjective anxiety and physiological arousal. Two music listening studies reported particularly large differences between control and experimental groups for subjective anxiety, but music listening and music therapy studies were not compared directly.

In the most recent of these Cochrane reviews, Bradt, Dileo, and Shim (2013) looked at the effectiveness of music interventions for preoperative anxiety. This review included 26 studies, all of which used music listening, published between 1994 and 2012.

Again, little information was found about the specific musical stimuli used, with most articles merely reporting the style or genre. In this review, five of the studies gave tempo information (all specifying that music was between 60 and 80 bpm). Only two studies used researcher-selected music, with the others giving patients the ability to choose between a number of pre-defined tracks.

They found that music listening was significantly (and consistently) more effective at reducing state anxiety than standard care control, as per the STAI-S (MD = -5.72, $p <$ 0.00001; $\chi^2 = 21.23$, $p = .05$, $I^2 = 43\%$). Similar results were found in the studies using other measures of subjective anxiety (SMD = -.60, $p < .0001$; $\chi^2 = 15.19$, $p =$ .02, $I^2 = 61\%$), although these were less consistent (again, due to some studies reporting particularly large effects).

Physiological measures yielded less consistent results: Although small effects were found on heart rate (MD = -2.77, $p = .006$; $\chi^2 = 70.64$, $p < .00001$, $I^2 = 79\%$), respiratory rate increased by a small but significant amount in response to music listening in comparison to standard care (MD = 0.97, $p < .00001$). This finding was incredibly inconsistent across studies ($\chi^2 = 135.24$, $p < .00001$, $I^2 = 96\%$).

This review found inconsistent results for music listening (apart from when looking at studies using the STAI-S for subjective anxiety, which were consistent). Perhaps this inconsistency can be attributed to the large amount of studies using patient-selected music. The greater number of stimuli usually used in patient-selected music in comparison with researcher-selected music, could provide one explanation for the inconsistency of the results reported in this review.

These Cochrane reviews demonstrated that music listening can reduce both subjective and physiological measures of anxiety with coronary heart patients, mechanically ventilated patients, cancer patients, and preoperative patients. This supports the idea that music listening has the capacity to reduce both subjective and physiological measures of anxiety. However, these contexts refer to patients with heightened levels of situational anxiety, who are likely to recover more quickly from anxiety-provoking situations than those with anxiety disorders. Indeed, an analysis in the review on music for coronary heart patients (Bradt & Dileo, 2009), comparing MI patients with surgical/procedural patients, suggests that listening to music could be particularly effective for those who find it difficult to regulate from stress, which is a characteristic of the anxiety disorders (Cisler et al., 2014).

The effects found were sometimes inconsistent between studies. Possible reasons for this inconsistency include: differences in types of anxiety experienced, illustrated by the difference found between MI patients and surgical/procedural patients (Bradt & Dileo, 2009); particularly large effects experienced in some studies; and varied responses when multiple stimuli were used.

The Cochrane reviews argue that, although positive effects are often found for music listening, the high levels of inconsistency between studies lead to a low quality body of evidence. Reporting of musical stimuli is particularly poor. These reviews highlight the need for more rigorously conducted RCTs exploring music listening (and other music interventions) in this context, which give more information on the music stimuli used, and the rationale behind stimulus selection.

The Cochrane reviews provide a snapshot of the evidence base for music listening in the treatment of anxiety. Referring to specific medical and surgical situations, they do not cover studies conducted outwith these contexts, or past the date of the most recent review (which considered studies published up to August 2012). However, two main themes can be pulled from these reviews that are reflected in the general body of music and anxiety literature: 1) Music listening has repeatedly been shown to be effective in reducing subjective and physiological measures of anxiety; and 2) despite these promising results, there is a great deal of inconsistency in the field.

2.3.2 Limitations

Although the Cochrane reviews refer to anxiety in specific situations (preoperative anxiety, and anxiety experienced by coronary heart patients, mechanically ventilated patients, and cancer patients), the limitations identified, in particular poor reporting of music-specific elements of a study, are a common occurrence in music listening and anxiety studies in many contexts.

Key areas that need improvement are terminology to accurately describe the music intervention used, and thorough description of the stimuli used, and these will now be discussed in more detail.

2.3.2.1 Terminology for music interventions

Terminology for the type of intervention is used inconsistently. The use of music as a therapeutic tool has developed into several different models. Unfortunately, these terms are often used incorrectly in the music and anxiety literature. This makes it difficult to conduct a review exploring one specific intervention, such as music listening, as it is often mislabelled as 'music therapy', meaning that potentially relevant articles may be excluded based on the title or abstract.

'Music therapy' is commonly used in the music and anxiety literature as a catch-all term to describe any situation where music is used with therapeutic intent. However, 'music therapy' has a more specific meaning, and associated regulatory requirements. The American Music Therapy Association (AMTA) state that 1) music therapy must be facilitated by "a credentialed professional who has completed an approved music therapy programme", and that 2) the music intervention should be conducted "within a therapeutic relationship" ("About Music Therapy & AMTA," n.d.). Similarly, in the United Kingdom, music therapists must have completed a postgraduate music therapy course at one of seven designated institutions ("MT training," 2011), and when defining music therapy, the British Association of Music Therapy (BAMT) specify that music therapy occurs within a therapeutic relationship ("Music therapy," 2011). As such, music listening can be considered an element of music therapy, as long as it is facilitated by a music therapist as part of a therapeutic relationship.

However, these two requirements are often overlooked in music and anxiety studies, and studies are often branded 'music therapy' when either one or both of the regulatory criteria are breached (L.-C. Chen, Wang, Shih, & Wu, 2013; Jiménez-Jiménez, García-Escalona, Martín-López, De Vera-Vera, & De Haro, 2013; Johnson, Raymond, & Goss, 2012; K.-C. Lee, Chao, Yiin, Chiang, & Chao, 2011; Li, Zhou, Yan, Wang, & Zhang, 2012; Shin & Kim, 2011; Yang et al., 2012).

Of these studies, a number cite definitions of music therapy which exclude these necessary regulatory criteria (Hilliard, 2005; Jiménez-Jiménez et al., 2013; Korhan, Khorshid, & Uyar, 2011; Vanin & Helsley, 2008; Yang et al., 2012). Unfortunately, these terms can then be adopted into literature reviews, with no clear distinctions made about the type of intervention used, leading to increasing confusion within the literature about what evidence has been gathered for what type of intervention.

2.3.2.2 Music stimulus

The Cochrane reviews identified that music stimuli are often described very poorly. As well as making studies very difficult to replicate, this also creates an inconsistent body of evidence. As discussed in Section 2.2.3, different features within the music have been associated with different emotional responses, and as such not all stimuli will be equally effective at reducing anxiety. It follows then, that using more or less appropriate stimuli will have more or less of an effect at reducing anxiety, and that this will result in an inconsistent body of literature. Even worse, when these stimuli are not reported in detail, there is no way to tell whether 'music' in general, or specific musical stimuli, were responsible for the results.

Stimulus decisions should be documented thoroughly, to enable future researchers to ascertain which stimuli have had beneficial effects, and to identify mechanisms behind these effects.

2.3.2.2.1 Who chooses the music?

2.3.2.2.1.1 Participant-chosen (or preferred) music

Although in many studies the stimuli are chosen by the experimenter, or a member of the research team, in some cases the participant is encouraged to select their own musical stimulus. Indeed, some researchers have suggested that this type of stimulus (known as 'preferred' or 'self-selected' music) can be particularly effective in reducing anxiety (Wakim, Smith, & Guinn, 2010). It should be noted here that 'preferred' music is of less relevance to this thesis, as it uses more personal mechanisms (see Section 2.2.1), which are harder to evoke in a controlled manner, and which could present potentially confounding variables in a trial evaluating a potential health intervention.

In some studies using preferred music, participants are given the freedom to select any music of their choosing. Unsurprisingly, these studies often provide little information about the stimulus, such as Kulkarni et al. (2012) and O'Callaghan et al.'s (2012) articles, which report that participants brought their own music, but give no further information about what music participants brought.

In other studies using preferred music, participants are asked to choose from a pre-defined set of stimuli. More detail is usually given in these studies, such as a list of genres (Johnson et al., 2012; J. Kushnir, Friedman, Ehrenfeld, & Kushnir, 2012; Li et al., 2012; Ni, Tsai, Lee, Kao, & Chen, 2012), a specific tempo or decibel level (K.-C. Lee et al., 2011; 2012), or a descriptive label such as "soft" (Johnson et al., 2012), "relaxing" (Chlan et al., 2013), or "light" (J. Kushnir et al., 2012). However, it would be more useful for researchers to provide specific details (such as composer, title, performance, and rationale) about each proffered selection, allowing for evaluation of the effectiveness of specific musical tracks and their component features.

2.3.2.2.1.2 Experimenter-chosen music

One would assume that in researcher-chosen music, more detail would be given about the stimulus. However, this is not always the case. Often there seems to be no rationale for the music chosen, with no description apart from "classical" music (Yeo, Cho, Oh, Park, & Park, 2013), "lyric recorded music" (Ottaviani et al., 2012), or the name of the composer (Norouzi, Keshavarz, SeyedFatemi, & Ali, 2013; Tsivian et al., 2012).

Some studies go into more detail about musical criteria which their stimuli comply with, although these often appear to be cursory. Several studies (S. Nilsson, Kokinsky, Nilsson, Sidenvall, & Enskär, 2009a; U. Nilsson, 2009; U. Nilsson, Lindell, Eriksson, & Kellerth, 2009b; Weeks & Nilsson, 2011) used MusiCure: "a specifically designed therapeutic music composed by Niels Eije according to the classical composing technique, however, without a specific genre appearance, characterised as genreless and as soundpheres. The music was designed to provide a calming influence without emotional triggering and included different melodies of 60 to 80 bpm" (Weeks & Nilsson, 2011, p. 90). However, without more specific details about the specific elements of MusiCure, it is difficult to tell which part of the stimulus was effective.

Despite the increasing amount of information in the music and emotion literature about stimulus selection, it is difficult to tell whether this information has been adopted into the majority of music and anxiety studies, because authors often provide very little information about the stimulus and how it was selected. This makes it hard to quantify the effectiveness of different types of stimuli, providing a barrier to further research and adoption of music listening into practice.

In future music and anxiety studies, both using participant-selected and researcher-selected stimuli, authors should specify the exact stimulus used. When multiple stimuli are used, separate results should be reported for the responses to each stimulus when feasible.

2.3.3 Guidelines

The Consolidated Standards of Reporting Trials (CONSORT) statement (developed by the CONSORT group) provides guidelines on reporting RCTs (Schulz, Altman, & Moher, 2010). Of particular relevance is item 5, which states that studies should include information on “the interventions for each group with sufficient details to allow replication, including how and when they were actually administered” (p. 835). In CONSORT’s explanation and elaboration (Moher et al., 2012), it was clarified that control interventions should not be neglected in the description. CONSORT also created a specific set of guidelines for nonpharmacologic treatment (Boutron et al., 2008). In these, they added several clarifications, including the importance of describing different components, how interventions were tailored, and how it was ensured that care providers adhered to the experimental protocol.

Despite the utility of these guidelines for general intervention reporting, there are a number of additional considerations when testing music interventions. Robb and Carter (2009) identified 11 music-specific components to consider: music qualities, music selection process, intervention materials, intervention components, intervention delivery schedule, interventionist, treatment fidelity, recipient, setting, format/unit of delivery, and music delivery method.

From these components, Robb et al. (2011) created a specific set of guidelines for reporting music-based interventions, designed to complement the existing CONSORT guidelines for RCTs and Transparent Reporting of Evaluations with Nonrandomised Designs (TREND) guidelines for nonrandomised designs. These guidelines should increase transparency and enable more accurate interpretation and replication of studies.

Robb and colleagues recommend that authors give detailed descriptions of 1) the rationale for the music they have chosen, and how they expect specific elements of the music to impact on outcome measures; 2) the music intervention, including who chooses the music, specific details of the music chosen, the method of delivery, and intervention strategies (such as music listening or songwriting); 3) the delivery schedule of the intervention; 4) the person conducting the intervention, their qualifications and credentials; 5) strategies used to maximise consistency of delivery; and 6) the setting. These do not seem to have been widely adopted yet.

Despite the inconsistencies in reporting, the evidence reported in the Cochrane reviews has shown that music listening can effectively reduce anxiety in a number of health related settings, such as preoperatively, with cancer patients, mechanically ventilated patients, and patients with coronary heart disease. However, as discussed in the first section of the literature review, those with anxiety disorders are more likely to have increased attentional bias to threat, difficulties with emotion regulation, and more dysfunctional negative perseverative thought, such as worry, and as such the anxiety experienced in these situations is likely to differ from that which characterises an anxiety disorder.

In addition, future studies should take care with methodological choices. Studies should take care to consider the music-specific elements, in particular the stimulus, and to describe this carefully. This will be addressed in this thesis by a careful stimulus selection procedure, and indeed this brings us to the aims of the thesis.

2.3.4 Aims of thesis

In this literature review a theoretical rationale has been established for music listening as being beneficial for those with anxiety disorders: Physiological arousal and worry have been identified as important components of anxiety to address within treatment, and a body of research has been introduced that supports the concept that music listening can reduce physiological arousal, and evoke positive emotions, the latter of which has been shown to reduce worry. Finally, the current evidence base for music listening in the treatment of anxiety (outwith anxiety disorders) has been explored.

This research has suggested that music can reduce anxiety in specific anxiety-provoking situations, outwith the context of anxiety disorders, although pooled results are sometimes inconsistent, and often suffer from poor reporting (particularly of music-specific elements).

However, these have not included the pathological worry component that is characteristic of anxiety disorders. As it has already been established that this type of worry is distinct from everyday worry experienced in advance of stressful situations, there is currently insufficient evidence to justify immediate testing with a clinical population.

Therefore, preliminary work is needed to explore the effects of music listening in response to an anxiety induction protocol (or 'psychological stressor') that models an anxiety disorder, and as such promotes increased physiological arousal and excessive worry. As worry refers to potential future danger, this anxiety induction protocol should involve anticipatory anxiety. Elements of uncontrollability and social-evaluative threat have also been identified as important components of a psychological stressor (Dickerson & Kemeny, 2004) and therefore should be included in research of this kind.

2.3.5 Artificial anxiety and anxiety symptoms

Three studies have previously explored the effects of music listening in response to an artificially-induced, anticipatory, psychological stressor (J. L. Burns, Labbé, Arke,

& Capeless, 2002; Knight & Rickard, 2001; Thoma et al., 2013). In addition, one study looked at the effect of adding music listening to a cognitive restructuring intervention for participants with high anxiety, but not specifically an anxiety disorder diagnosis (Kerr, Walsh, & Marshall, 2001). Finally, a very recently-published study (J. K. Lee & Orsillo, 2014) used music as an active control in a study investigating cognitive flexibility for those with symptoms of generalised anxiety disorder (GAD). These studies will now be discussed.

Burns and colleagues (2002) randomised participants (n = 60) to listen to classical music (*Serenata Notturna, KV 239*, by Mozart), rock music (*So Close* by Alice in Chains), self-selected music (a CD of the participant's own choosing), or to sit in silence during a ten-minute anticipatory period before a "difficult and stressful mental rotations task test" (p. 105). Measures of relaxation (via a Likert-type scale), state anxiety (via the state scale of Spielberger's State Trait Anxiety Inventory), and heart rate were taken after being told about the task (time 1), and after the experimental phase (listening to music or sitting in silence, time 2).

Between time 1 and 2, an increase in relaxation, and a decrease in state anxiety was seen for participants in the self-selected (relaxation: $p < .001$; anxiety: $p < .001$), classical (relaxation: $p = .001$; anxiety: $p < .001$), and control (relaxation: $p = .001$; anxiety: $p = .001$) conditions. Analyses exploring changes in heart rate were not reported, but the classical condition had significantly lower mean heart rate at time 2 than the control and self-selected conditions ($p = .003$). No analyses explored the interaction between time and condition.

Although this study included music listening in an anticipatory period, it had a number of limitations. Firstly, the authors did not posit any specific rationale for the use of music, merely citing the evidence that music has been shown to induce relaxation and cause physiological changes. The specific stimuli used were defined but not rationalised. Secondly, no measure was taken before the participants were told about the mental rotations task, and as such it is not possible to ascertain whether anticipatory anxiety was induced. Thirdly, all participants were asked to bring a CD (in case they were randomised into the self-selected group), which may have alerted them to the nature of the experiment and affected participants' blinding.

Knight and Rickard (2001) asked participants (n = 89, tested together in groups of between 6 and 12) to prepare for an oral presentation which they would then be asked to deliver to the other members of the group. In the twelve-minute preparation period, participants either listened to music (Pachelbel's *Canon in D major*) or sat in silence. As the preparation period was the window of interest, participants were debriefed after this phase, and told they would not have to give the presentation. Results showed that the anxiety induction was highly effective, with increases found between pre and poststressor measures of subjective anxiety, systolic blood pressure, and heart rate (all $p < .001$). Music listening was better than silence at combatting anticipatory anxiety, with subjective anxiety ($p < .001$), systolic blood pressure ($p < .005$), and heart rate ($p < .005$) staying static for the music condition and rising for the control condition.

Like Burns and colleagues, Knight and Rickard introduced the evidence surrounding music's ability to reduce anxiety as per a variety of measures, but they do not propose a specific mechanism behind this effect. They rationalise their use of stimulus, having chosen it due to its effects in previous studies.

Despite the anticipatory nature of the study and the presence of social-evaluative threat, the protocol did not model the worry-based nature of an anxiety disorder closely enough to justify immediate testing with a clinically-anxious population. Encouraging participants to prepare for the presentation decreased the sense of uncontrollability over the situation, and as such discouraged, rather than promoted, worry.

A recent study by Thoma and colleagues (2013) expanded on the work of Knight and Rickard. This study tested the effects of music listening in an anticipatory period on a variety of psychological and physiological measures. Anxiety was induced using a modified version of the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993). The TSST involves an anticipatory period, where participants are asked to prepare a presentation for a mock job interview, following which participants must give the presentation in front of an intimidating panel, and then answer questions. Thoma and colleagues adapted the protocol by only giving minimal information about the presentation, just saying that participants would be asked to undertake a public speaking task. This was designed to encourage participants not to prepare for the presentation in the anticipatory period.

Thoma and colleagues considered the potential mechanisms behind music and anxiety reduction. They discussed the research exploring music's effects on stress-induced cortisol release, suggesting that music can be beneficial in this context, potentially because of its ability to activate cognitive processes in the brain, and evoke emotional responses.

Participants ($n = 60$) were randomised to either listen to relaxing music, to water ripple sounds, or to silence (control condition) in the anticipatory period. No significant interaction effects were found for salivary cortisol ($p = .146$), salivary alpha-amylase ($p = .318$), heart rate ($p = .692$), RSA ($p = .533$), subjective stress ($p = .213$), or state anxiety ($p = .213$).

The authors hypothesised that this was an indicator that music listening was only effective in response to mild stressors, such as Knight and Rickard's, and that their protocol was too strong. However, an alternative explanation is that although removing the opportunity to prepare for the presentation decreased the sense of uncontrollability over the situation, the minimal amount of information provided about the task reduced the potential for worry, and therefore the level of psychological stress induced. Indeed, state anxiety decreased for all conditions between the beginning and the end of the listening phase. Experiments aiming to promote worry, rather than anxiety generally, should give participants more information about the public speaking task, while still discouraging preparation.

Kerr and colleagues (2001) examined music listening as a means of enhancing cognitive restructuring with participants with high anxiety, but not specifically with participants with anxiety disorders. In their study, participants ($n = 40$) were randomised to music-assisted cognitive restructuring or standard cognitive restructuring. All participants were asked to visualise an anxiety-provoking situation, and then participants in the music condition listened to music for five music. Then, all participants were asked to visualise positive thoughts in relation to the anxiety-provoking situation. Results showed that the music condition was associated with reduced anxiety and increased positive affect, suggesting that music listening facilitated the cognitive restructuring. This suggests, preliminarily, that music could be effective in reducing anxiety within the context of anxiety disorders. However, they used participants without diagnoses of anxiety disorders, and as such did not include the worry associated with an anxiety disorder.

Very recently, an article has been published by Lee and Orsillo (2014) that used music as an active control condition for a study exploring the effects of mindfulness at increasing cognitive flexibility in individuals with symptoms of generalised anxiety disorder (GAD). In their study, participants ($n = 53$) were randomised to either mindfulness, music listening, or thought wander conditions. The state scale of Spielberger's State Trait Anxiety Inventory (STAI) was used as a manipulation check to examine levels of anxiety before and after the experimental conditions, and as such is of relevance to this thesis. All conditions lasted twenty minutes. Those in the music condition listened to *Air on the G string in D major*, by Johann Sebastian Bach, *Canon in D major* by Johann Pachelbel, and *Violin Concerto in D major Op. 77* by Johannes Brahms. The authors hypothesised that those in the mindfulness and music listening conditions would have significant decreases in state anxiety, but that those in the thought wandering condition would not. In fact, paired t-tests showed that significant reductions in state anxiety were found for the mindfulness condition ($p = .005$) and the thought wandering condition ($p = .016$), and that the reduction in state anxiety was bordering on significance for the music condition ($p = .051$) This lack of difference between conditions (particularly between thought wandering and the other two conditions) suggests that the everyday presence of GAD symptoms was not sufficient to truly examine the effects of mindfulness or music listening, and that it could be more beneficial to examine interventions in a situation where the symptoms have been triggered.

2.4 Summary

This literature review has proposed a theoretical rationale for the use of music listening in the treatment of anxiety disorders. Music listening has the capacity to reduce physiological arousal and promote positive affect, both of which have potential benefits for treating anxiety disorders. Physiological arousal is a symptom of anxiety, and thus decreasing it could be beneficial in the context of exposure therapy. Although there is some debate regarding the appropriateness of using safety behaviours or coping skills, with some arguing that these reduce the long-term effectiveness of exposure therapy, others posit that reducing physiological symptoms is an important component, promoting habituation to the anxiety-provoking situation. Either way, a benefit for reducing physiological arousal can be seen in making exposure therapy more acceptable for patients with acute anxiety in the early stages of treatment.

According to the mood-of-input hypothesis of perseverative thought, affective states play a role in the perseveration of dysfunctional thought, such as worry. In particular, negative affect has been associated with increased perseverative thought, especially when paired with "as many as can" stop rules, which are characteristic of anxiety disorders. As such, promoting positive affect could reduce the perseveration of worry.

Different musical features have been associated with different emotional responses, and as such not all music will be equally effective at promoting positive affect and reducing physiological arousal. As such, music and emotion literature was reviewed, with the purpose of selecting a list of criteria for choosing optimal musical stimuli: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

Next, the evidence base for music listening's capacity to reduce anxiety, as per measures of subjective anxiety and physiological arousal, in health contexts provoking situational anxiety was reviewed. Cochrane reviews found music listening to be effective at reducing both subjective anxiety and physiological arousal with coronary heart patients, mechanically ventilated patients, cancer patients, and preoperative patients, although these results were sometimes inconsistent between studies. Reporting in the included studies was deemed to be poor, specifically with reference to description of the musical stimulus, and this phenomenon was explored more widely in music and anxiety studies. The need for future studies to provide specific details about the music stimulus used was emphasised.

Finally, several studies were reviewed that have tested music listening in situations using artificial anxiety protocols or with participants with anxiety symptoms. These studies did not provide sufficient evidence to progress to a study testing music listening with anxiety disorders, as they either did not promote the perseverative negative thought associated with anxiety disorders, or did not aim to trigger anxiety symptoms.

Having completed the first stage of this project, i.e literature review as per the adapted MRC guidelines, it has been established that, while there is a theoretical rationale for using music listening in the treatment of anxiety disorders, and evidence supporting the use of music listening in other anxiety contexts, there is currently insufficient evidence to proceed to a clinical study. Preliminary work is needed in the form of the development and implementation of a proof-of-concept study testing music listening in a situation analogous to anxiety disorders, and this work is the focus of the next two chapters.

Chapter 3 Development

This chapter reports the development phase of the adapted MRC guidelines, which includes the preparatory work needed before the analogue, proof-of-concept study. This includes the development and evaluation of both the intervention (that is, selection of stimuli) and an anxiety induction protocol designed to model an anxiety disorder. Thoughout, methods were tested and refined to inform the analogue, proof-of-concept, exploratory trial.

3.1 Initial stimulus selection

Chapter 2 introduced the intended role of music listening: to reduce physiological arousal and promote positive affect, and the different musical features that have been associated with these effects. Not all music will be equally effective in reducing anxiety, and as such, it is of key importance to select stimuli appropriately with this purpose in mind.

The first section of this chapter reports the initial stimulus selection, which identified two optimal stimuli to be examined further in the stimulus explorations. This process involved:

- The identification of a set of stimulus inclusion criteria for optimal stimuli, as discussed in the literature review
- A Facebook poll to identify stimuli perceived as relaxing, and analysis of said stimuli in reference to the stimulus inclusion criteria to create a refined pool of stimuli which fit the inclusion criteria
- A rating exercise to further refine this pool

It is important to bear in mind that the initial stimulus selection was not an attempt to evaluate a large body of music systematically, or to select stimuli in a comprehensive manner. Instead, after the identification of the stimulus inclusion criteria, the rest of the stimulus selection phase was designed to reduce the bias associated with only the researcher being involved in selecting the stimuli, and to gain subjective ratings of the stimuli.

3.1.1 Stimulus inclusion criteria

In Chapter 2, music psychology articles were examined for evidence of musical features which have been associated with low arousal and positive valence (the quadrant of the dimensional model of emotion which best reflects reduced anxiety), and for studies that had already identified stimuli as falling within this quadrant.

A list of stimulus inclusion criteria was synthesised and compiled: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes (see Table 3.1).

Table 3.1: Stimulus inclusion criteria

Articulation	Legato
	Unaccented
Dynamic	Quiet dynamic
	No sudden changes
Harmony/tonality	Major mode
	Simple harmony
	Consonant harmony
Tempo and rhythm	Slow tempo
	Clear rhythm

The main exclusion criterion was the presence of lyrics, as these provide an additional semantic meaning and potential extra-musical emotional associations.

The first of the two stimuli, *Nocturne* (Op. 9 No. 2), by Chopin, was taken from a previous study (Coutinho & Cangelosi, 2011), where it had been identified as low arousal and positive valence (i.e. “relaxing”) on the circumplex model of affect, and met the stimulus inclusion criteria outlined in Table 3.1. In Coutinho and Cangelosi's study, participants rated various stimuli in real-time on a dimensional model. Chopin's *Nocturne* (Op. 9 No. 2) was consistently rated as inducing positive valence and low arousal. This stimulus was chosen for exploration in this thesis because it had previously been rated using a dimensional model and found to fall within the optimal quadrant for reducing anxiety.

A second stimulus was sought in order to investigate the appropriateness of the chosen criteria. To choose this second stimulus, a process was carried out to reduce the influence of researcher bias. The decision to compare a stimulus chosen from the literature with one chosen based purely on the stimulus inclusion criteria and a further selection process was a means of assessing the effectiveness of the stimulus inclusion criteria. In this stimulus selection process, an initial body of perceived relaxing music was chosen. This music was analysed with reference to the criteria, and then rated by a small panel in a rating exercise. This process is now outlined in more detail.

3.1.2 Facebook poll

To identify an initial selection of music which was found relaxing, a Facebook poll was carried out within my (the experimenter's) informal social network.

The poll asked for people to give examples of music they found relaxing, and which contained no lyrics. Classical music, soundtracks, world music, and folk were suggested genres.

These stimuli were then narrowed down based on the stimulus inclusion criteria. Eight tracks which best fitted these criteria were chosen for further exploration in a rating exercise (see Table 3.2):

Table 3.2: Optimal, relaxing stimuli

Piece	Composer
'Prelude' from *Cello Suite*	Johann Sebastian Bach

Piece	**Composer**
No. 1	
***Nocturne* (No. 5 in B flat major)**	John Field
Movement 2 (‘Romance’) from *Piano Concerto No. 20, KV 466*	Wolfgang Amadeus Mozart
‘Aquarium’ from *Carnival of the Animals*	Camille Saint-Saëns
‘The Swan’ from *Carnival of the Animals*	Camille Saint-Saëns
‘Romance’ from *The Gadfly Suite*	Dmitri Shostakovich
‘Fragments of Memories’, from *Final Fantasy VIII*	Nobuo Uematsu

3.1.3 Rating exercise

To choose one stimulus from the list, four participants (all music psychology PhD students or postdoctoral researchers) were asked individually to rate each stimulus for felt (or induced) arousal and valence. Using induced ratings was decided as the best way to select tracks for future study as it matched with the aim of this series of studies: to explore music’s ability to elicit emotions rather than merely display them. It also had a dual function: As well as gaining perspective on other music psychologists’ opinions of the emotions elicited by the music, this was a way to test the scales used before the first music listening study.

For this exercise, each rater listened to excerpts from each selected track, and rated them on two Likert scales: 1) an arousal scale, from deactivation (-3) to activation (+3), and 2) a valence scale, from pleasantness (-3) to unpleasantness (+3). These terms were taken from the circumplex model of affect (Russell, 1980; Russell & Barrett, 1999), the emotional model on which initial stimulus selection was based. For the instructions given, see Appendix A. Rather than referring to specific physiological responses, the 'arousal' scale was designed for raters to express how activated or deactivated they felt. Raters were specifically instructed to give responses based on how they felt, rather than on emotions perceived within the music. Raters were also invited to comment on each excerpt.

As well as the relaxing pieces, several excerpts were chosen which had features correlated with high arousal or negative valence. This was to increase variability of responses (otherwise expected responses would all have fallen in similar areas of the scales), and to identify "anxious" tracks to contrast with the relaxing stimuli for future studies. These anxious tracks contained one or more structural features that constitute high arousal (the inverse of the low arousal features), such as fast tempo, staccato articulation, minor or atonal harmony, dissonant harmony, complex rhythm, or loud dynamic (see Table 3.3).

Table 3.3: Opposing, anxious stimuli

Piece	Composer
'Allegro', from *Brandenburg Concerto No. 4*	Johann Sebastian Bach
String quartet	Alban Berg
'The Countdown Begins', from *Final Fantasy VII*	Nobuo Uematsu

Piece	Composer
'Opening chest motif', from *The Legend of Zelda: Ocarina of Time*	Koji Kondo
'Sacrificial dance', from *The Rite of Spring*	Igor Stravinsky
'One Winged Angel', from *Final Fantasy VII*	Nobuo Uematsu
'Who Are You', from *Final Fantasy VII*	Nobuo Uematsu

Raters listened to all relaxing and anxious tracks in random orders. Track order was generated by Random.org's list generator.[7] Raters were asked to rate each excerpt immediately after they had heard it.

Results were plotted on a graph with axes for arousal and valence, as in the circumplex model of affect (Russell, 1980; Russell & Barrett, 1999), and a single observer visual inspection of the ratings data was used to select the final stimulus: Saint-Saëns' 'The Swan' from *Carnival of the Animals* was chosen as the optimal relaxing stimulus.

The chosen stimulus was rated as optimally relaxing by the fourth participant (who had the reworded rating scale), with the highest possible valence score (+3) and the lowest possible arousal score (-3). It was also rated within the requisite quadrant (valence +1, arousal −2) by another participant. One participant rated it as maximum (+3) valence, but also maximum (+3) arousal. However, she marked in the comments

[7] http://www.random.org/lists/

that she noticed herself breathing deeply, and commented verbally that she had understood the rating scale to refer to mental activation rather than physiological activation. As high arousal states (such as anxiety) are usually associated with shallow, rather than deep, breathing (D. A. Clark & Beck, 2010), her response was interpreted as emotionally engaging rather than physiologically activating. The other participant rated it as maximum valence (+3) but also mildly physiologically arousing (+1). However, she mentioned that she was familiar with the track, and had played it on piano, which could have been a confounding variable.

This process had two limitations, which were very helpful in informing the next stage of experimental work.

One such limitation was the wording of the "arousal" scale. During the study, it became apparent that the words denoting high and low arousal (activation and deactivation) were ambiguous, and that at least one rater had misunderstood the meaning. The participant in question had marked a number of tracks as "activating", or high arousal, while commenting that it made them breathe more deeply (when in fact shallow, fast breathing is usually associated with anxiety and high arousal). It seemed that this rater had interpreted the scale to relate to mental activation and engagement, rather than physiological activation. To make the scale less ambiguous, it was reworded for the final rater, using "calm" for low arousal and "tense/energetic" for high arousal.

A second limitation was the lack of accounting for the musical experiences of the raters. As musical specialists, they had a range of instrumental and vocal experience, meaning that many had played some of the pieces in question. This was particularly relevant to pianists, because many of the pieces selected were for piano (as this is a harmonic instrument, and as such can retain a quiet dynamic while providing harmonies). It is possible that this affected ratings, as participants reported prior associations which could affect their emotional responses. In the next stages, participants were asked about their associations with the music.

3.2 Stimulus explorations

Following the selection of two optimal stimuli, by Chopin and Saint-Saëns, two initial exploratory studies were conducted (both with the same cohort).

As with the stimulus selection phase, these stimulus explorations were not designed as a comprehensive means of evaluating the stimuli. Two exploratory studies, with small sample sizes, were chosen as a means of looking at the within-subject responses to varying musical stimuli and quiet rest.

Rather than immediately beginning with a large study, this phased approach allowed careful testing and development of methods for the proof-of-concept study, as well as exploration and identification of trends in the participants' ratings of and responses to the music.

3.2.1 Stimulus exploration 1

3.2.1.1 Aims

The aims of this study were threefold: 1) to explore trends in listening to the relaxing stimuli before or after an anxious stimulus (chosen during the stimulus selection phase, for more information see Section 3.2.1.2.2); 2) to explore the effect of repetition by repeating the relaxing stimuli; 3) to gain further ratings on the selected stimulus. This study also provided the opportunity to test various elements of the methods (such as measures, design, and location).

3.2.1.2 Methods

3.2.1.2.1 Participants

Eight participants took part in this study (sex: 7 female, 1 male; age: $M = 30.13$, range = 24-53, $SD = 9.52$).

A convenience sample was used. Participants were recruited from a general population, via word of mouth, and were all students, graduates, or staff members from the University of Edinburgh.

3.2.1.2.2 Stimuli

Optimal stimuli were identified in the stimulus selection phase discussed earlier in the chapter (see Section 3.1): Chopin's *Nocturne* (Opus 9, No. 2), and Saint-Saëns', 'The Swan', from *Carnival of the Animals.*

An anxious stimulus was also chosen from the rating study, to explore trends when listening to stimuli with characteristics associated with the opposing quadrant of the circumplex model of affect.

The chosen anxious stimulus was Nobuo Uematsu's 'One-Winged Angel', from the video game *Final Fantasy VII*. This was selected from a visual inspection of the plotted ratings as the stimulus most identified as "activating" (high arousal) and "unpleasant" (negative valence), containing features such as fast tempo, dissonant, minor harmony, sudden changes in pitch, and pulsing rhythm.

Details of the stimuli can be seen in Table 3.4.

Table 3.4: Stimulus exploration 1 stimuli

Type	Piece	Composer	Duration
Anxious (A)	'One Winged Angel', from *Final Fantasy VII*	Nobuo Uematsu	1m09s
Relaxing (R1)	*Nocturne Op. 9 No. 2*	Frédéric Chopin	4m32s
Relaxing (R2)	'The Swan', from *Carnival of the Animals*	Camille Saint-Saëns	3m44s

3.2.1.2.3 Design

This exploratory study had a randomised, within subjects design, meaning that all participants experienced anxious music, relaxing music, and quiet rest conditions.

The combination of relaxing and anxious stimuli was presented in two different orders. Within these two orders, the order of the relaxing stimuli was counterbalanced, to explore the effect of order. Relaxing stimuli were both played twice, to explore the effect of repetition on pulse rate.

A within subjects design was chosen because it allowed exploration of responses when stimuli were heard in differing orders, as a means of identifying trends for further investigation.

The order of tracks can be seen Table 3.5.

Table 3.5: Order of stimuli

Order 1a	A R1 R2 R1 R2
Order 1b	A R2 R1 R2 R1
Order 2a	R1 R2 R1 R2 A
Order 2b	R2 R1 R2 R1 A

Before hearing the stimuli, participants experienced a five minute habituation period after arrival, a one minute baseline period, and a three minute quiet rest period. The habituation period was designed to allow pulse rate to normalise after arrival. Between each stimulus, participants experienced a one minute adjustment period, during which time they would either complete a music questionnaire (see Section 3.2.1.2.4.2), if it was the first playing of a stimulus, or sit quietly. After the end of the last adjustment period, participants experienced another three minute quiet rest period. Figure 3.1 and Figure 3.2 detail the procedure for orders 1 and 2, respectively, and Figure 3.3 provides a legend for these figures. Further details can be found in the "procedure" section of the methods (see Section 3.2.1.2.5).

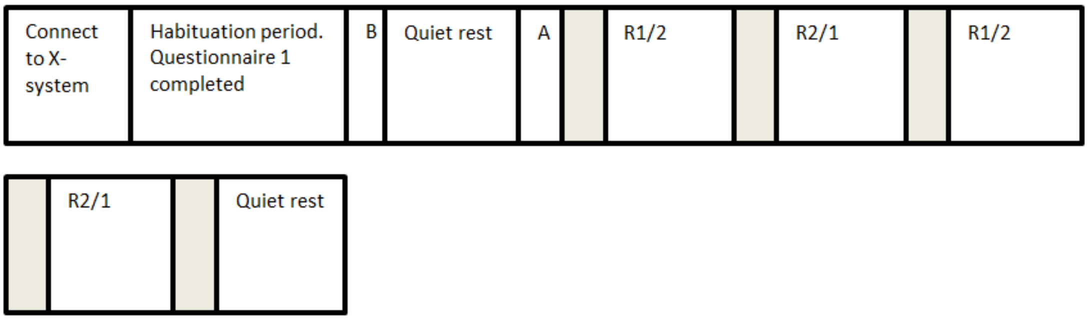

Figure 3.1: Procedure for order 1a and 1b

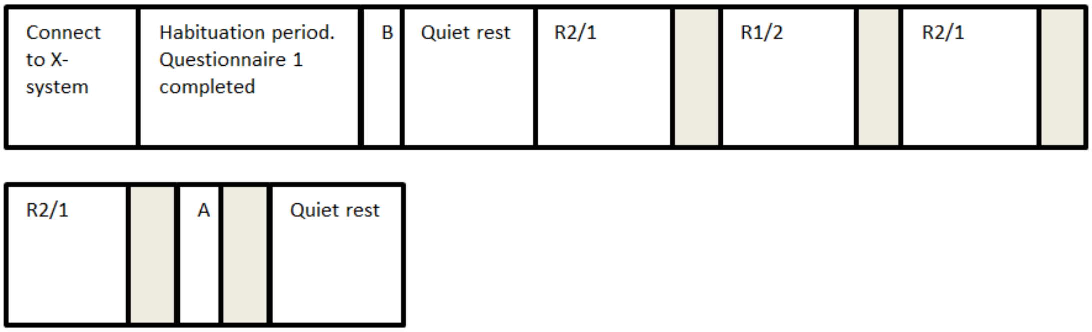

Figure 3.2: Procedure for order 2a and 2b

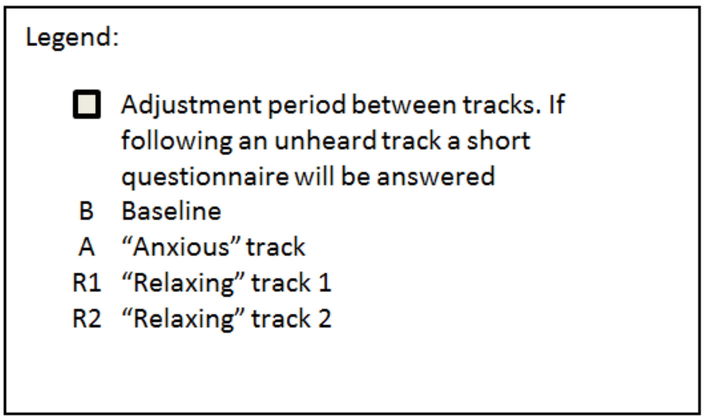

Figure 3.3: Legend for procedure diagrams

3.2.1.2.4 Measures

3.2.1.2.4.1 Pulse rate

As anxiety can result in increased heart rate (or pulse rate, Bradt et al., 2013), these are commonly-used physiological measures in music and anxiety studies (such as

Augustin & Hains, 1996; DeMarco, Alexander, Nehrenz, & Gallagher, 2012; J. Kushnir et al., 2012; D. Lee, Henderson, & Shum, 2004; K.-C. Lee et al., 2011; 2012; P.-C. Lin, Lin, Huang, Hsu, & Lin, 2011; Ni et al., 2012; Winter, Paskin, & Baker, 1994; P. M. B. Yung, Kam, Lau, & Chan, 2003; P. Yung, Kam, & French, 2002).

In this study, pulse rate, in beats per minute (bpm), was measured using a transmissive infrared fingertip sensor worn on the middle fingertip of the non-dominant hand. The sensor averages pulse rate values over four seconds, with a new average calculated approximately 10 times per second. This device was produced by Nonin Medical,[8] an established manufacturer of medical devices. Data was transmitted live to a netbook using equipment developed by Mobile Healthcare Networks (MHN) Ltd.[9]

Pulse rate was measured continuously from connection of the system at the beginning of the session, to disconnection after the end, with mean values calculated for baseline, both quiet rest periods, and each stimulus period (see Section 3.2.1.2.5).

3.2.1.2.4.2 Questionnaires

Three questionnaires were administered in this study: a demographic questionnaire, a music rating questionnaire, and a final questionnaire. As well as a means for gathering information for this study, these were also administered as as a way of piloting the questionnaires for use in later studies.

3.2.1.2.4.2.1 Demographic questionnaire

The demographic questionnaire was given at the beginning of the session, asking for basic demographic information and details of musical training (see Appendix B).

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[8] http://www.nonin.com/index.aspx

[9] http://www.mobilehealthcarenetworks.com/

3.2.1.2.4.2.2 Music rating questionnaire

The music rating questionnaire (see Appendix C) was given after each stimulus was heard for the first time. This questionnaire asked the participants to rate the music on Likert scales (-3 to +3) for liking (-3 strongly disliked, 0 neutral, +3 strongly liked), arousal (-3 extremely tense/energetic, 0 neutral, +3 extremely calm), and valence (-3 extremely negative, 0 neutral, +3 extremely positive). These Likert scales were similar to those used in the stimulus selection phase. 7-point Likert scales were chosen for liking, arousal, and valence because they present a clear way for participants to indicate a strong, moderate, small, or neutral response. They also provided a means of identifying the quadrant of the circumplex model of affect in which the participants' ratings fell, by considering the arousal and valence ratings together.

Participants were also invited to rate their familiarity with the music, from 1 (never heard) to 4 (definitely know and could identify). Questions on familiarity and liking were included as a potential means of further exploring unusual responses to the musical stimuli.

In the arousal and valence questions, it should be noted that participants were asked to rate how they felt in response to the music rather than whether they perceived the music to have the qualities in question. Wording was particularly challenging for the arousal question. It seemed most appropriate to include both "tense" and "energetic" at the left hand side of the scale, so as to cancel out the negative and positive (respectively) connotations associated with each word. The researcher ensured to explain this question to each participant. With the rating study (see Section 3.1.3), the words "activated" (instead of "tense/energetic") and "deactivated" (instead of "calm") were used for the first three participants. However, this caused confusion with one participant, leading to a change in wording for the subsequent expert participants, and for the first exploratory pilot.

3.2.1.2.4.2.3 Final questionnaire

The final questionnaire (see Appendix D), given at the end of the study, asked for further information regarding liking of and familiarity with each stimulus. This included questions on whether the participants had any associations with the stimuli, and whether these were positive, negative, or neither. This information was requested at the end of the study, rather than within the other questionnaires, so as to ensure minimal disruption between musical stimuli. There were also questions on any mental health or heart conditions, and consumption of caffeine, tobacco, or alcohol before the session.

3.2.1.2.5 Procedure

Participants arrived and were seated in a desk chair. They read through the information sheet (see Appendix E) with the researcher, and were given the opportunity to ask questions before signing the consent form.

Following this, they were connected to the pulse rate sensor and completed the demographic questionnaire. The order of the study was then discussed with the participant (that they would be asked to listen to music and sit quietly throughout the study; participants were not told that they would be listening to different categories of music stimuli). They were advised that they could move if they were uncomfortable, but that they should stay as quiet as possible during the baseline and quiet rest periods (although participants were not told there was a distinction between these periods, they were just asked to sit quietly), and that they should try not to move excessively. After at least four minutes of sitting quietly (remaining habituation period, one minute baseline period, three minutes quiet rest period), the participant was helped to put on the headphones, and the first track was started.

Between each piece, there was a one-minute pause. If it was the first playing of a track, the participant was given the music rating questionnaire. If it was the second playing of a track, the participant quietly awaited the next track. After the final track and one-minute follow-up, there was a final three-minute quiet rest period, after which the participant was disconnected from the pulse sensors and completed the final questionnaire.

3.2.1.2.6 Ethics

The study was approved by Level 1 Ethics in the School of Health in Social Science, College of Humanities and Social Sciences, University of Edinburgh. All participants read an information sheet, were informed that their participation was voluntary and that they could withdraw at any time, and signed a consent form.

3.2.1.3 Results

This was an exploratory study, with a small sample size (n = 8) and a number of different orders. As such, inferential statistics were not used for analysis.

As such, descriptive statistics are provided for the pooled music rating scores, and then a case study approach is taken, with physiological responses plotted on a line graph for each participant. Demographic information and music rating scores are reported for each participant, and trends are identified. Before this, the appropriateness of the methods is discussed.

3.2.1.4 Appropriateness of methods

3.2.1.4.1 Measures

An initial pitfall was the effect of cold fingers, which made it difficult for the oximeter to measure pulse correctly. This resulted in the system disconnecting briefly before reconnecting. Although this was clear in the results and did not contaminate the data, it was unclear at first why this was happening. Being aware of the problem that cold fingers can bring means that in future, participants can be asked to wash their hands with warm water if problems seem possible.

The lack of psychometric tests (measuring mood or anxiety, for example) meant that it was not possible to judge any effect the music had on these. This will be addressed in the study design of the next experiment.

3.2.1.4.2 Design

The varied pulse rate responses to the later stimuli suggest that the study may have been too long, which could have altered physiological arousal via a boredom effect (Merrifield & Danckert, 2013).

3.2.1.4.3 Location

The setting of the study was not particularly conducive to promoting relaxation. The participants sat in a desk chair at a table, and had to keep relatively still to avoid contaminating the data. The researcher was facing each participant across the corner of the table, observing the pulse rate on the laptop screen, and taking notes. Although no participants commented that this was offputting in any way, the researcher felt that it nevertheless may have been so. Skin resistance sensors were worn, but unfortunately these were found not to be functional so data could not be used. One participant commented that the sensors (fabric straps to go around two individual fingers) were uncomfortable.

3.2.1.4.4 Descriptive statistics

3.2.1.4.4.1 Liking, valence, and arousal

Pooled music ratings can be found in Table 3.6. These include liking, valence (how negative or participants participants felt), and arousal (how calm or tense participants felt).[10]

For liking, the anxious stimulus (Uematsu) was rated as the least liked track (mean of -0.08 on a scale of -3 [strongly disliked] to 3 [strongly liked]). The Chopin piece was rated at 2.25, and the Saint-Saëns at 2.63, close to the maximum score of three.

For valence, the anxious stimulus was rated as least positive (mean -0.13), then the Chopin (1.88) and the Saint-Saëns (2), meaning that the Chopin and the Saint-Saëns generally made participants feel more positive.

For calmness (arousal), results follow the same pattern, with the anxious stimulus rated as -1.38 (with -3 being extremely tense/energetic), the Chopin as 1.13 (with +3 being extrememly calm) and the Saint-Saëns as 1.25.

Table 3.6: Liking, valence, and arousal

Stimulus	Liking	Valence (positive)	Arousal
A (Uematsu)	-0.08	-0.13	-1.38

[10] In this pilot, the arousal scale was framed as a "calmness" scale, meaning that increased ratings were associated with increased calmness, and therefore decreased arousal.

Stimulus	Liking	Valence (positive)	Arousal
R1 (Chopin)	2.25	1.88	1.13
R2 (Saint-Saëns)	2.63	2	1.25

3.2.1.4.5 Case studies

Demographic information for all participants can be seen in Table 3.15 and details of participants' musical training can be seen in Table 3.16.

3.2.1.4.5.1 Participant 1: Order 1a (A R1 R2 R1 R2)

3.2.1.4.5.1.1 Demographic information

Participant 1 was a 28-year old female, who had learned the piano for seven years. She reported no mental health or heart conditions, and had consumed one cup of coffee and one cigarette in the three hours preceding the session.

3.2.1.4.5.1.2 Music ratings

Participant 1's music ratings can be seen in Table 3.7. She reported disliking the anxious stimulus quite a bit (-2), liking the Chopin quite a bit (2), and liking the Saint-Saëns a lot (3). She found that the anxious stimulus made her feel slightly less calm (-1) and slightly less positive (-1), the Chopin made her quite a bit more calm (2) and positive (2), and the Saint-Saëns made her feel a lot more calm (3) and quite a bit more positive (2). She had never heard the anxious stimulus before, knew and could identify the Chopin, and thought she had heard the Saint-Saëns before. The two pieces that she had heard previously were associated with positive emotions.

Table 3.7: Participant 1's music ratings

	A	R1	R2
Liking	-2	2	3

Calmness	-1	2	3
Valence (positive)	-1	2	2
Familiarity	1	4	2
Association	Negative*	Positive	Positive

*Despite reporting a negative association, participant 1 also reported being completely unfamiliar with the stimulus.

3.2.1.4.5.1.3 Pulse rate

Participant 1’s pulse rate can be seen in Figure 3.4.

At baseline, participant 1’s mean pulse rate was 73.06 beats per minute (bpm). It dropped slightly in the first rest period (72.3) and again during the anxious stimulus (72.19). It dropped more dramatically during the Chopin (67.61), and rose slightly during the Saint-Saëns (70.37). It dropped again for the second playing of the Chopin (66.6) and even more for the second playing of the Saint-Saëns (61.23). In the last quiet rest period it rose again (66.12).

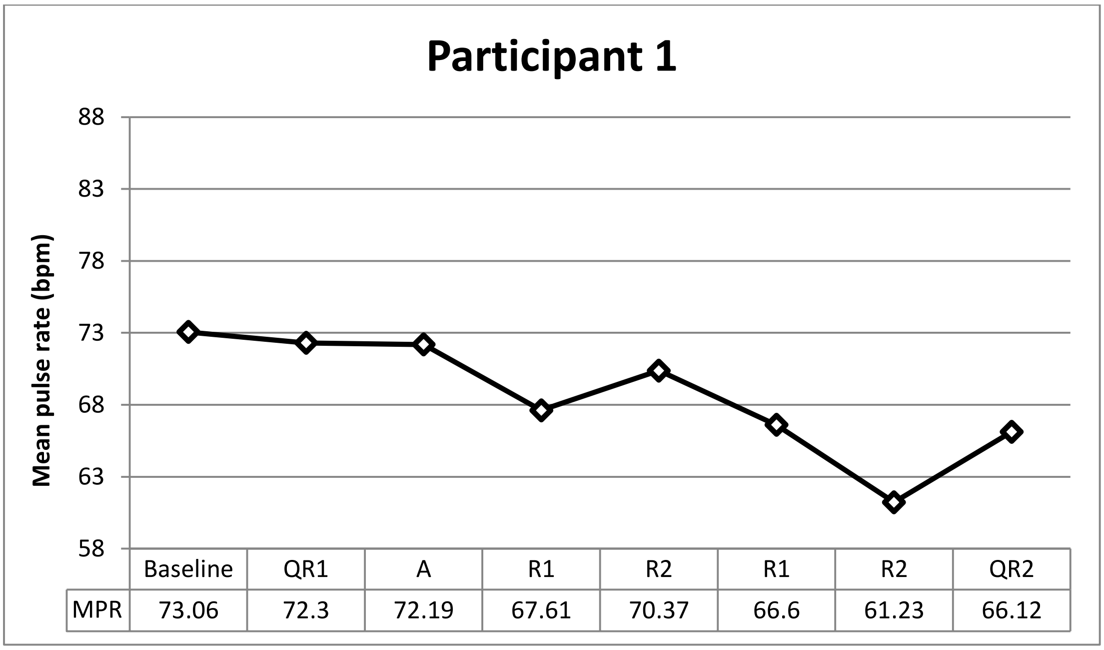


Figure 3.4: Participant 1's pulse rate

3.2.1.4.5.1.4 Observations

The anxious stimulus was not linked to an increased mean pulse rate for participant 1, but pulse rate did drop in the relaxing stimulus immediately following the anxious stimulus. Mean pulse rate rose again for the second iteration of the first relaxing stimulus.

3.2.1.4.5.2 Participant 2: Order 2a (R1 R2 R1 R2 A)

3.2.1.4.5.2.1 Demographic information

Participant 2 was a 30-year old female, who had received piano lessons for 7 years. She reported no mental health or heart conditions, and had consumed one cup of coffee in the three hours preceding the session.

3.2.1.4.5.2.2 Music ratings

Participant 2's music ratings can be seen in Table 3.8.

Participant 2 reported disliking the anxious stimulus quite a bit (-2), and liking the Chopin and the Saint-Saëns a lot (3). The anxious stimulus and the Saint-Saëns made her feel slightly less calm (-1), and the Chopin made her feel slightly more calm (1). The anxiety stimulus did not made her feel more positive or negative, and the Chopin and the Saint-Saëns made her feel much more positive (3). She was completely unfamiliar with the anxious stimulus but had heard and could identify both the Chopin and the Saint-Saëns. Both the Chopin and the Saint-Saëns were associated with positive emotions.

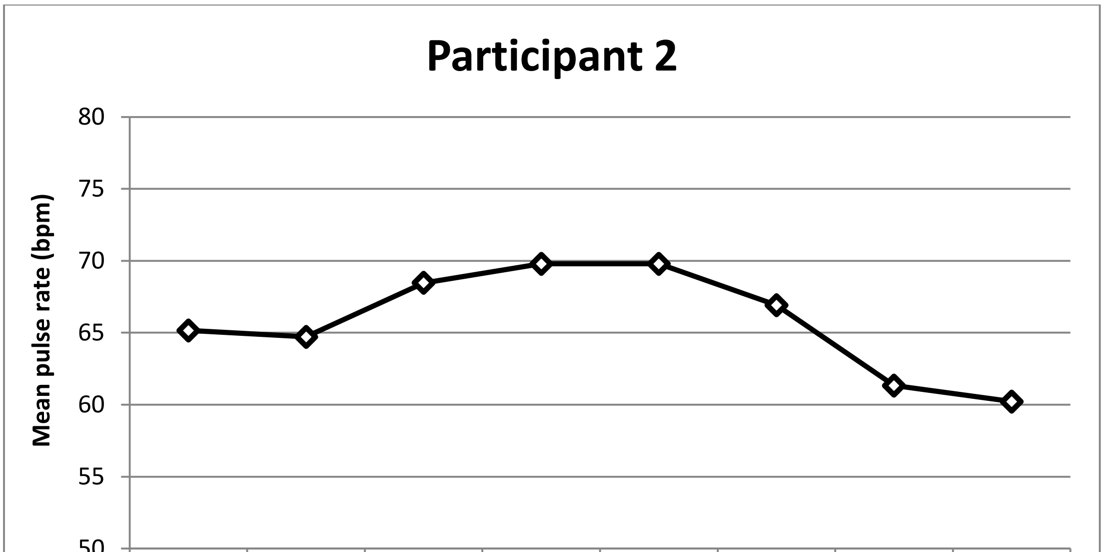
Table 3.8: Participant 2's music ratings

	A	**R1**	**R2**
Liking	-2	3	3
Calmness	-1	1	-1
Valence (positive)	0	3	3

Familiarity	1	4	4
Association	None	Positive	Positive

3.2.1.4.5.2.3 Pulse rate

Participant 2's pulse rate results can be seen in Figure 3.5. At baseline, participant 2's mean pulse rate was 65.16 bpm. It dropped slightly in the first quiet rest period (64.72) but rose more dramatically with the Chopin (68.46), and again slightly for the Saint-Saëns (69.79). It stayed the same for the second playing of the Chopin (69.79) and dropped for the second playing of the Saint-Saëns (66.92). It dropped more dramatically for the anxious stimulus (61.33), and a little more for the second quiet rest period (60.22).



	Baseline	QR1	R1	R2	R1	R2	A	QR2
MPR	65.16	64.72	68.46	69.79	69.79	66.92	61.33	60.22

Figure 3.5: Participant 2's pulse rate

3.2.1.4.5.2.4 Observations

The first relaxing stimulus (immediately following the initial quiet rest phase) was associated with an increased pulse rate. Conversely, pulse rate fell during the anxious stimulus.

3.2.1.4.5.3 Participant 3: Order 1b (A R2 R1 R2 R1)

3.2.1.4.5.3.1 Demographic information

Participant 3 was a 53-year old female, with no musical training. She reported no mental health or heart conditions, and had consumed one cup of tea in the three hours preceding the session.

3.2.1.4.5.3.2 Music ratings

Participant 3's music ratings can be seen in Table 3.9. Participant 3 reported disliking the anxious stimulus a bit (-1), liking the Chopin a lot (3), and liking the Saint-Saëns quite a bit (2). The anxious stimulus made her feel quite a bit less calm (-2), and the Saint-Saëns and the Chopin made her feel quite a bit more calm (2). The anxious stimulus made her feel a bit more positive (1), and the Saint-Saëns and the Chopin made her feel quite a bit more positive (2). She was unfamiliar with the anxious stimulus, and had heard both the Saint-Saëns and the Chopin but couldn't identify them. Both the Saint-Saëns and the Chopin were associated with positive emotions.

Table 3.9: Participant 3's music ratings

	A	**R1**	**R2**
Liking	-1	2	3
Calmness	-2	2	2
Valence (positive)	1	2	2
Familiarity	1	3	3
Association	None	Positive	Positive

3.2.1.4.5.3.3 Pulse rate

Participant 3's pulse rate results can be seen in Figure 3.6. At baseline, pulse rate was 58.93 bpm, moving to 60.14 in the quiet rest period. During the anxious stimulus it rose to 64.3, lowering to 62.24 with the Saint-Saëns, and dropping further to 61.49 for the Chopin. It rose up to 65.16 for the second playing of the Saint-Saëns, then dropped to 60.61 with the second playing of the Chopin. With the second quiet rest period it rose to 63.43.

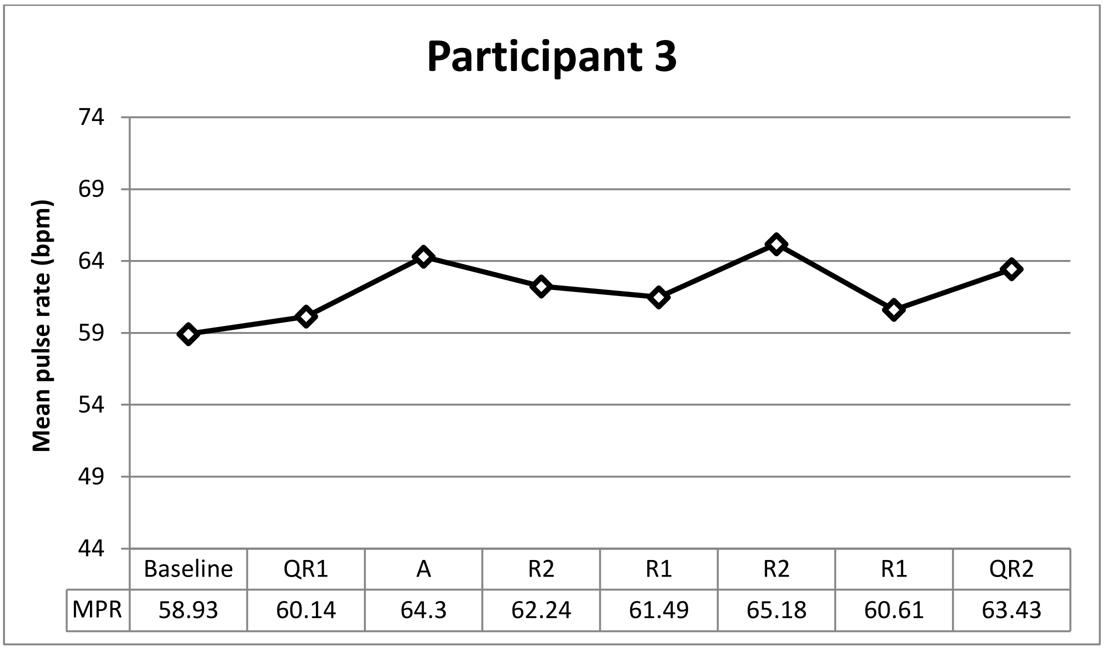


Figure 3.6: Participant 3's pulse rate

3.2.1.4.5.3.4 Observations

For participant 3, pulse rate rose during the initial anxious stimulus, and then dropped again during the first relaxing stimulus. Her pulse rate rose for the second iteration of the first relaxing stimulus.

3.2.1.4.5.4 Participant 4: Order 2b (R2 R1 R2 R1 A)

3.2.1.4.5.4.1 Demographic information

Participant 4 was a 30-year old male, who had received 1 year of singing lessons. He reported no mental health or heart conditions.

3.2.1.4.5.4.2 Music ratings

Participant 4's music ratings can be seen in Table 3.10. Participant 4 liked the Saint-Saëns and the Chopin a bit (1), and the anxious stimulus quite a bit (2). He marked the Saint-Saëns and the Chopin as making him feel a bit calm (1), and the anxious stimulus as a bit less calm (-1). He felt neither positive nor negative in response to the Saint-Saëns (0), and the other two stimuli made him feel a bit more positive (1). He was familiar with both relaxing stimuli, but couldn't name them (3), and he was completely unfamiliar with the anxious stimulus (1). He had positive associations with both relaxing stimuli.

Table 3.10: Participant 4's music ratings

	A	**R1**	**R2**
Liking	2	1	1
Calmness	-1	1	1
Valence (positive)	1	1	0
Familiarity	1	3	3
Association	Positive*	Positive/neither	Positive/neither

*Despite reporting a positive association, participant 4 also reported being completely unfamiliar with the stimulus.

3.2.1.4.5.4.3 Pulse rate

Participant 4's pulse rate results can be seen in Figure 3.7. Participant 4's pulse rate was 65.47 bpm at baseline. It increased during the first quiet rest period to 68.43, dropping to 64.76 for the Saint-Saëns. It rose through the relaxing pieces to 69.34 at the second playing of the Chopin. The pulse rate reduced to 67.09 for the anxious stimulus, and to 66.22 for the final rest period.

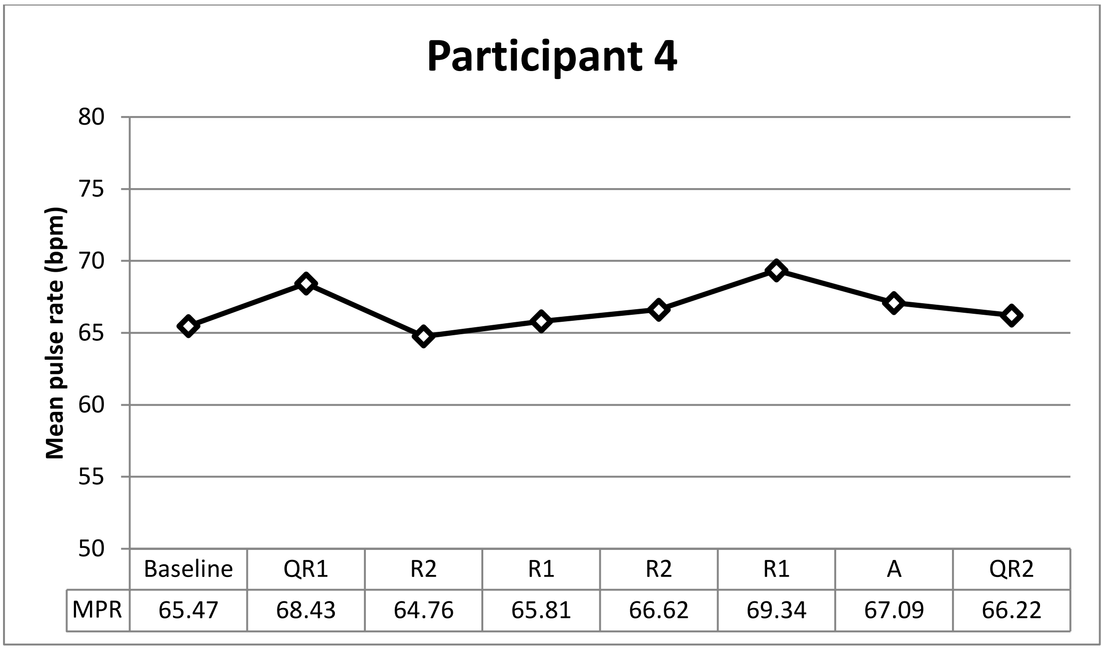


Figure 3.7: Participant 4's pulse rate

3.2.1.4.5.4.4 Observations

Participant 4 was unusual in liking the anxious stimulus more than the relaxing stimuli. His pulse rate dropped for the initial relaxing stimulus, rose steadily, and then dropped for the anxious stimulus.

3.2.1.4.5.5 Participant 5: Order 1a (A R1 R2 R1 R2)

3.2.1.4.5.5.1 Demographic information

Participant 5 was a 26-year old female, with 7 years of accordion, 13 years of piano, 5 years of saxophone, and 9 years of theory. She reported no mental health or heart conditions.

3.2.1.4.5.5.2 Music ratings

Participant 5’s music ratings can be seen in Table 3.11. In the first study, she reported disliking the anxious stimulus a bit (-1), and liking the relaxing stimuli a lot (3). She felt a bit less calm after the anxious stimulus (-1), a bit more calm after the Chopin (1), and a lot more calm after the Saint-Saëns (3). She felt a bit less positive after the anxious stimulus (-1), a bit more positive after the Chopin (1), and a lot more positive after the Saint-Saëns (3). She was unfamiliar with the anxious stimulus, familiar with the Chopin but could not identify it (3, although she had played it), and very familiar with the Saint-Saëns (4).

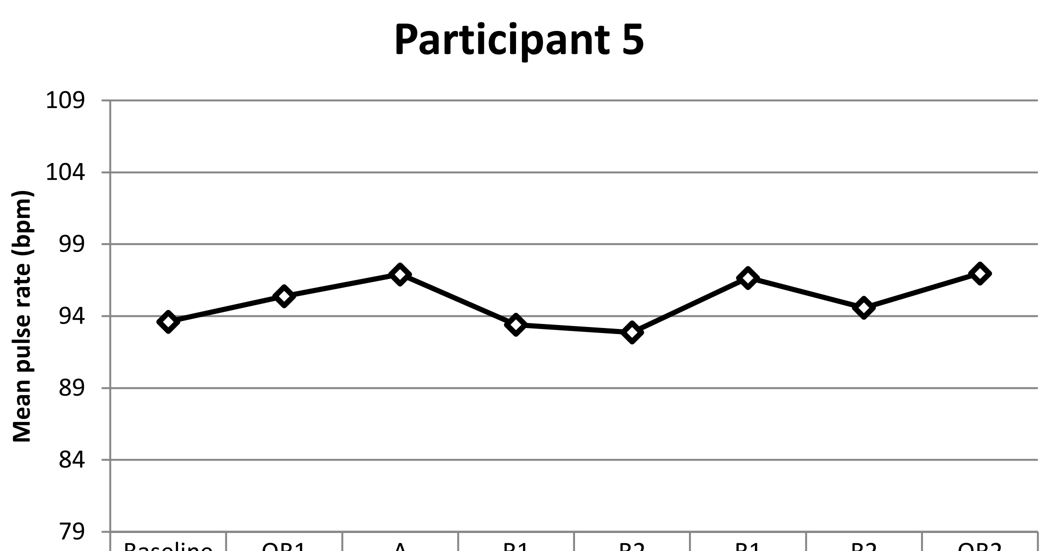
She had associated the Chopin with both positive and negative memories (having played it), and the Saint-Saëns with positive memories.

Table 3.11: Participant 5's music ratings

	A	R1	R2
Liking	-1	3	1
Calmness	-1	1	1
Valence (positive)	-1	1	0
Familiarity	1	3 (and had played)	3
Association	None	Positive/neither	Positive

3.2.1.4.5.5.3 Pulse rate

Participant 5's pulse rate results can be seen in Figure 3.8. Participant 5's pulse rate was 93.62 bpm at baseline. It rose during the initial quiet rest phase (95.38) and anxious stimulus (96.91), lowering for the first playing of the Chopin (93.4) and the Saint-Saëns (94.58). It rose for the second rendition of the Chopin (96.67), dropped slightly for the second playing of the Saint-Saëns (94.58), and rose again for the final quiet rest phase (96.98).



	Baseline	QR1	A	R1	R2	R1	R2	QR2
MPR	93.62	95.38	96.91	93.4	92.87	96.67	94.58	96.98

Figure 3.8: Participant 5's pulse rate

3.2.1.4.5.5.4 Observations

Participant 5's pulse rate rose for the first anxious stimulus, and dropped for the following relaxing stimulus. Her pulse rate rose for the second iteration of the first relaxing stimulus.

3.2.1.4.5.6 Participant 6: Order 2a (R1 R2 R1 R2 A)

3.2.1.4.5.6.1 Demographic information

Participant 6 was a 24-year old female, with one year of piano lessons, and half a year of flute lessons. She reported no mental health or heart conditions.

3.2.1.4.5.6.2 Music ratings

Participant 6's music ratings can be seen in Table 3.12. Participant 6 liked both relaxing stimuli a lot (3), and disliked the anxious stimulus quite a bit (-2). She felt quite calm after the Chopin (2), very calm after the Saint-Saëns (3), and quite stressed after the anxious stimulus (-2). She didn't feel any more positive or negative after the relaxing stimulus (0), but she did feel quite a lot less positive after the anxious stimulus (-2). She was familiar with the Chopin but couldn't name it (3), and she felt like she might have heard the Saint-Saëns and the anxious stimulus (2). She had positive associations with the Chopin, and no associations with the other two stimuli.

Table 3.12: Participant 6's music ratings

	A	R1	R2
Liking	-2	3	3
Calmness	-2	2	3
Valence (positive)	-2	0	0
Familiarity	2	3	2
Association	None	Positive	None

3.2.1.4.5.6.3 Pulse rate

Participant 6’s pulse rate results can be seen in Figure 3.9. Participant 6’s baseline pulse rate was 47.73 bpm, rising slightly for the first quiet rest period (49.11) , going down for the first playing of the Chopin (48.03) and up very slightly for the first playing of the Saint-Saëns (48.17). It dropped for the second playing of the Chopin (47.36), slightly below baseline, rose slightly for the second playing of the Saint-Saëns (48.93), and rose more for the anxious stimulus (50.12). For the final quiet rest phase, pulse rate was 49.39.

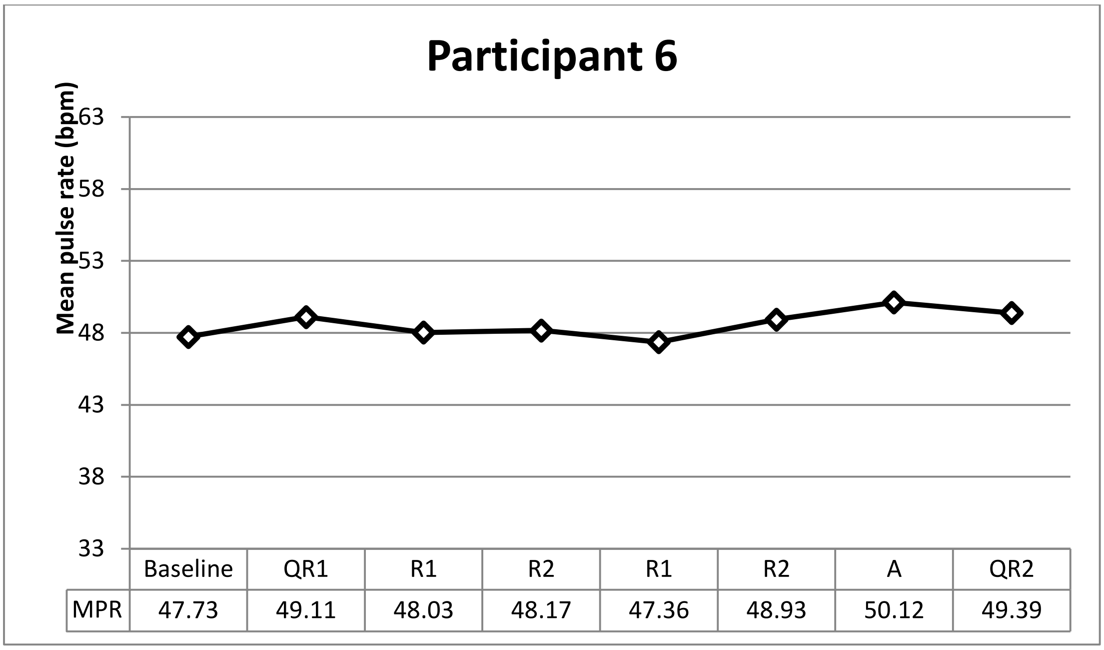


Figure 3.9: Participant 6's pulse rate

3.2.1.4.5.6.4 Observations

Participant 6’s pulse rate dropped slightly for the first relaxing piece, and rose for the final anxious piece.

3.2.1.4.5.7 Participant 7: Order 1b (A R2 R1 R2 R1)

3.2.1.4.5.7.1 Demographic information

Participant 7 was a 25-year old female. She had played clarinet for 9 years. She reported no mental health or heart conditions, and had consumed 2 cups of tea in the three hours preceding the session.

3.2.1.4.5.7.2 Music ratings

Participant 7’s pulse rate results can be seen in Table 3.13. Participant 7 liked the anxious stimulus and the Chopin quite a bit (2), and the Saint-Saëns a lot (3). She reported feeling quite a bit less calm after the anxious stimulus (-2), and a lot more calm after the relaxing stimuli (3). She felt quite a bit more positive after the anxious stimulus (2), a bit less positive after the Saint-Saëns (-1), and quite a bit less positive after the Chopin (-2). She thought she might have heard the anxious stimulus (2), knew and could identify the Saint-Saëns (4), and knew but could not identify the

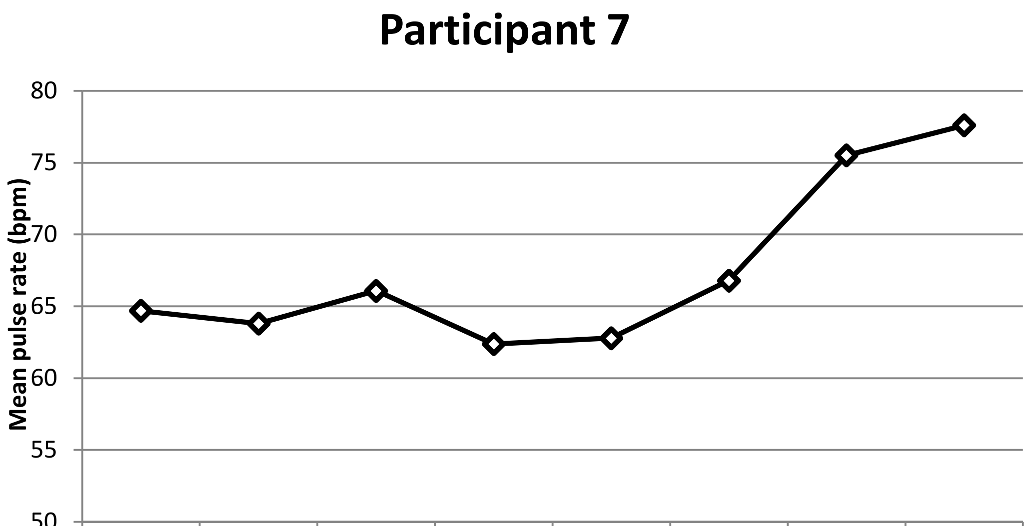
Chopin (3). She had no associations with the anxious stimulus, but negative associations with both relaxing stimuli.

Table 3.13: Participant 7's music ratings

	A	R1	R2
Liking	2	2	3
Calmness	-2	3	3
Valence (positive)	2	-2	-1
Familiarity	2	3	4
Association	None	Negative	Negative

3.2.1.4.5.7.3 Pulse rate

Participant 7's pulse rate results can be seen in Figure 3.10. Participant 7's baseline pulse rate was 64.69 bpm, reducing to 63.8 during the first quiet rest phase. For the anxious stimulus it rose to 66.08, lowering to 62.38 for the Saint-Saëns and rising slightly to 62.79 for the Chopin. It rose again to 66.8 for the second playing of the Saint-Saëns, and to 75.52 for the second playing of the Chopin It peaked at 77.6 during the final quiet rest phase.



	Baseline	QR1	A	R2	R1	R2	R1	QR2
MPR	64.69	63.8	66.08	62.38	62.79	66.8	75.51	77.6

Figure 3.10: Participant 7's pulse rate

3.2.1.4.5.7.4 Observations

Participant 7 had negative associations with both of the relaxing stimuli. Although her pulse rate initially dropped in the first relaxing stimulus following the anxious stimulus, it rose, first slowly, and then more dramatically, for the further instances of the relaxing stimuli.

3.2.1.4.5.8 Participant 8: Order 2b (R2 R1 R2 R1 A)

3.2.1.4.5.8.1 Demographic information

Participant 8 was a 25-year old female, with three years of piano lessons. She reported no mental health or heart conditions, and had consumed 1 cup of green tea in the three hours preceding the session.

3.2.1.4.5.8.2 Music ratings

Participant 8's music ratings can be seen in Table 3.14. Participant 8 liked both relaxing stimuli quite a bit (2), and disliked the anxious stimulus quite a bit (-2). She felt quite calm after the Saint-Saëns (2), very calm after the Chopin (3), and a bit stressed after the anxious stimulus (-1). She felt a bit more positive after the second playing of the Saint-Saëns (1), quite a bit more positive after the Chopin (2), and a bit more negative after the anxious stimulus (-1). She had heard the relaxing stimuli before but couldn't identify them (3), and had not heard the anxious stimulus (1). She had no associations with the music.

Table 3.14: Participant 8's music ratings

	A	R1	R2
Liking	-2	2	2
Calmness	-1	3	2
Valence (positive)	-1	2	1
Familiarity	1	3	3
Association	Negative*	Neither	N/A

*Despite reporting a negative association, participant 8 also reported being completely unfamiliar with the stimulus.

3.2.1.4.5.8.3 Pulse rate

Participant 8's pulse rate results can be seen in Figure 3.11. Participant 8's pulse rate was 68.33 bpm at baseline, rising very slightly to 68.56 for the first quiet rest phase, to 69.09 for the Saint-Saëns, and to 69.87 for the Chopin. It lowered slightly to 68.14 for second playing of the Saint-Saëns, and rising to 68.53 for the second playing of the Chopin. It rose to 72.45 for the anxious stimulus, and was at its lowest for the final quiet rest phase (66.35).

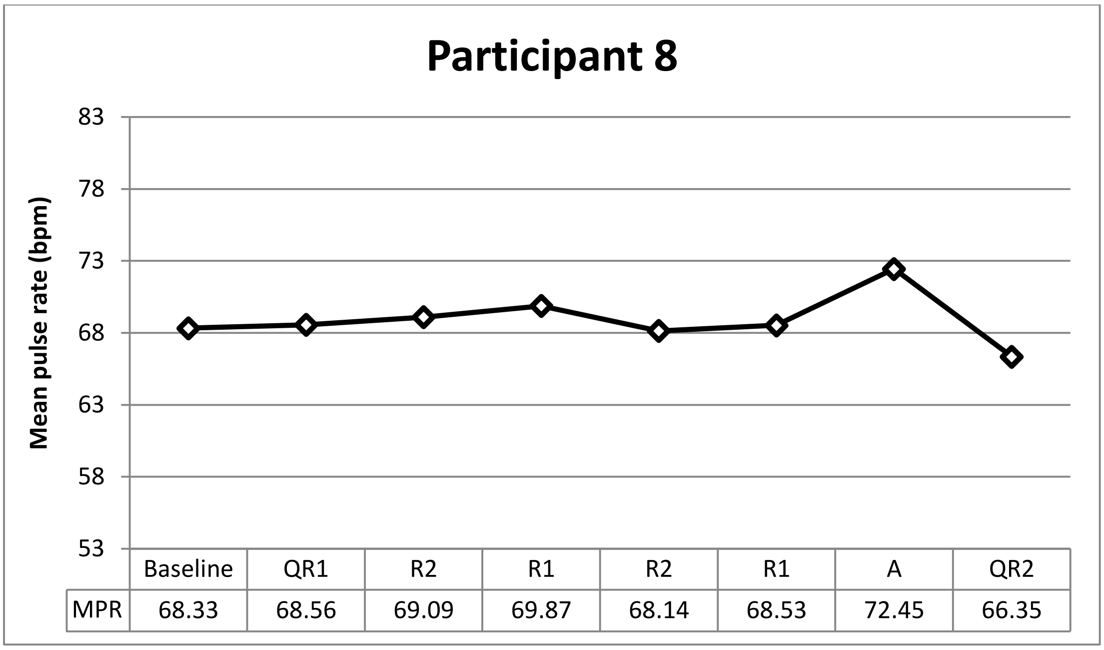


Figure 3.11: Participant 8's pulse rate

3.2.1.4.5.8.4 Observations

Participant 8’s pulse rate rose slightly for the first two relaxing stimuli. It increased for the final, anxious stimulus.

Table 3.15: Demographic information

	P1	P2	P3	P4	P5	P6	P7	P8
Age	28	30	53	30	26	24	25	25
Sex	F	F	F	M	F	F	F	F
Mental health conditions	None	None	None	None	None	None	None	None
Heart conditions	None	None	None	None	None	None	None	None
Substance consumption	Coffee, 1 cup; cigarette, 1	Coffee, 1 cup	Tea, 1 cup	None	None	None	Tea, 2 cups	Green tea, 1 cup

Table 3.16: Musical training information

Participant ID	**Instrument (years)**
Participant 1	Piano (7)
Participant 2	Piano (7)
Participant 3	
Participant 4	Singing (1)
Participant 5	Accordion (7) Piano (13) Saxophone (5) Theory (9)
Participant 6	Piano (1) Flute (0.5)
Participant 7	Clarinet (9)
Participant 8	Piano (3)

Table 3.17: Pulse rate trends

		Order 1a/b				Order 2a/b				
Order	**Pulse rate trend**	**P1**	**P3**	**P5**	**P7**	**P2**	**P4**	**P6**	**P8**	**Total**
1a/b	**Rose for first stimulus (A)**	No	Yes	Yes	Yes	N/A	N/A	N/A	N/A	3 of 4
	Rose for second stimulus (R after A)	Yes	Yes	Yes	Yes	N/A	N/A	N/A	N/A	4 of 4
2a/b	**Rose for first stimulus (R)**	N/A	N/A	N/A	N/A	Yes	No	No	Yes	2 of 4
	Rose for second stimulus (R after R)	N/A	N/A	N/A	N/A	No	No	No	No	0 of 4
	Rose for A	N/A	N/A	N/A	N/A	Yes	No	Yes	Yes	3 of 4

		Order 1a/b				Order 2a/b				
All	**Rose for first repetition**	No	Yes	Yes	Yes	No	Yes	No	No	4 of 8
	Rose for fourth stimulus	No	Yes	Yes	Yes	No	Yes	Yes	Yes	6 of 8

3.2.1.4.6 Comments

Users were invited to mark any comments that they wished to make about the study (including anything they liked, or any changes they thought should be made). Several participants commented that they had difficulty staying awake, either via these comments or orally to the researcher, which could suggest that the intervention had a relaxing effect on the participants. Several also commented that they enjoyed the experiment. One suggested that a more comfortable chair was used for future experiments.

3.2.1.5 Discussion

3.2.1.5.1 Trends

Descriptive statistics showed that the relaxing stimuli were mostly rated as low arousal and positive valence, and the anxious stimulus was mostly rated as high arousal and negative valence. These ratings were similar to those in the previous rating exercise.

Mean liking ratings showed that the anxious stimulus was least liked, and promoted most negative valence, and highest arousal, of the three stimuli. The Saint-Saëns was most liked, inspired most positive valence, and lowest arousal, with Chopin ratings a close second.

Observation of the line graphs for each participant showed several trends (see Table 3.17).

For orders 1a and 1b (where the anxious stimulus was presented first, followed by both relaxing stimuli played twice), pulse rate rose between the quiet rest phase and the anxious stimulus. For all four participants in orders 1a and 1b, pulse rate dropped between the anxious stimulus and the following relaxing stimulus.

For orders 2a and 2b (where the relaxing stimuli were played first, then repeated, and the anxious stimulus was presented last), pulse rose for the first stimulus for two of four participants, and rose for the anxious stimulus (presented last) for three of four participants.

For all orders, pulse rate rose for the first repetition in four of eight participants (three from order 1, and one from order 2). For six of eight participants (three from order 1 and three from order 2), pulse rate rose for the fourth stimulus.

3.2.1.5.1.1 Reaction to first stimulus

The increase in pulse rate in 3 of the 4 participants for order 1 suggested that music with features associated with high arousal and low valence can increase physiological arousal.

However, only one fewer participant experienced an increase in pulse rate for the first stimulus in order 2, where this was a relaxing stimulus.

3.2.1.5.1.2 Reaction to second stimulus

Whether or not the initial increase in pulse rate was related to the characteristics of the musical stimulus, it is interesting to observe the responses to the second stimulus (which is relaxing in both orders - one following an anxious stimulus [for order 1], and one following a relaxing stimulus [for order 2]).

The drop in pulse rate in the relaxing stimulus following the anxious stimulus for order 1 suggested that listening to music with features associated with low arousal and high valence can reduce physiological arousal in the presence of a stressor.

For order 2, no participants experienced a drop in pulse rate at this point. A pattern can be identified from this: When listening to a relaxing stimulus, pulse rate was more likely to drop if it was following an anxious stimulus than another relaxing stimulus, potentially irrespective of observed pulse rate in reaction to that first stimulus.

3.2.1.5.1.3 Reaction to repetition

The increase in pulse rate found in three of four participants in order 1 for the repetition of the first relaxing stimulus was not expected. In fact, the opposite had been expected, because of previous findings of repetition being associated with decreased physiological arousal (Iwanaga et al., 2005). One potential explanation is that this was due with the length of the study, and that participants were bored by this stage. Indeed, research has shown that pulse rate can increase in response to boredom (Merrifield & Danckert, 2013).

To further examine this response to repeated stimuli, the other order was examined for a similar effect. For order 2, the repetition of the first relaxing stimulus was associated with a drop in physiological arousal for two participants, a very slight rise for one participant, and no change for one participant, showing a different response to the participants in the other order.

To examine the role of the length of the study, the the results of all participants were examined for an effect on the fourth stimulus. In this situation, six participants experienced an increase in pulse rate. This trend is more in keeping with that experienced in order 1, and suggests that perhaps it was the length of the study that induced the less consistent results at this stage.

3.2.1.5.1.4 Reaction to anxious stimulus

Whether presented first or last, the same number of participants (three of four for each order) had increased pulse rate for the anxious stimulus.

3.2.1.5.2 Limitations

This study was exploratory, with a small sample size, and as such none of the results should be generalised. Trends were identified, which will be explored further in future stages, but it should be noted that these are merely patterns, not statistically significant findings, and as such could have occurred via random chance. However, these trends did identify themes for future research.

The imbalance in gender could be seen as a limitation, but a previous study (Knight & Rickard, 2001) found that males and females had similar reactions to listening to relaxing music. As the study was conducted with participants living in Scotland, all were likely to be familiar with Western music, meaning that these results should not be generalised to a non-Western population. Seven participants had experienced formal music training, with four participants having seven or more years of musical training, which may not be representative of most populations.

The restriction of musical genres could be seen as another limitation. The study used video game music and Western classical music. The reasoning behind this was that Western tonal classical music (the rules of which also apply to much game music and film music) is what has been studied in most depth by music psychologists in regards to the structural components of emotion. While popular music is also usually tonal, the lyrics add a unwanted complex dimension, as do the social and emotional associations which are likely to be present.

Other than the limitations identified previously, such as the uncomfortable chair, the positioning of the researcher in reference to the participant, the complications from cold fingers, the length of the study, and the lack of psychometric tests, no problems were identified with the methods of the study. The identified problems informed the methods of a second stimulus exploration.

3.2.1.5.3 Direction

The musical ratings suggest that the selected stimuli are appropriate for further study. Further research is needed to explore the effects these stimuli have on mood and state anxiety.

A number of trends were identified, most notably that after an anxious stimulus, pulse rate dropped in a following relaxing stimulus. This was of particular interest: Not only did it suggest that there were differing responses to different emotional stimuli, it also suggested that the relaxing music was particularly effective at reducing pulse rate when following an anxious stimulus, and that the anxious musical stimulus was acting as a mild form of anxiety induction.

However, it is not known whether this reduction in pulse rate was due to the presence of the relaxing stimulus or the absence of the anxious stimulus. As such, a second stimulus exploration was conducted to explore these issues.

3.2.2 Stimulus exploration 2

A second stimulus exploration was conducted with the same cohort to further explore the effect of listening to relaxing music after an anxious stimulus. Of particular interest was the response to stimuli presented after an anxious stimulus, whether it be quiet rest or relaxing music.

In response to the first stimulus exploration, a number of changes were made, related to stimulus orders, subjective measures, and set-up.

3.2.2.1 Methods: Changes

3.2.2.1.1 Study length

In light of the raised pulse rate seen in response to the fourth stimulus in six of the eight participants in the first stimulus exploration, this second stimulus exploration was shorter, with two fewer stimulus instances.

3.2.2.1.2 Stimulus

In this stimulus exploration, the anxious stimulus was changed to 'Sacrificial Dance', from *The Rite of Spring*, by Igor Stravinsky.

There were two main reasons for this: 1) The anxious music used in the second stimulus exploration is longer, closer in length to the relaxing pieces (4m31s); and 2) The anxious music used in the follow-up is one cited as "excitative" in the literature (Iwanaga et al., 2005) and its irregular rhythms makes it likely to increase physiological arousal more than the previous anxious track.

3.2.2.1.3 Stimulus order

As no trend was observed for repetition of stimuli, relaxing stimuli were not repeated.

Different orders were introduced to explore whether the drop in pulse rate could be attributed to existence of relaxing stimulus or to removal of anxious stimulus.

In the second stimulus exploration, tracks were played in the following orders (see Table 3.18):

Table 3.18: Order of stimuli

Order 1a	A R1 R2

Order 1b	A R2 R1
Order 2a	A QR R1
Order 2b	A QR R2
Order 3a	R1 R2 A
Order 3b	R2 R1 A
Order 4a	R1 QR A
Order 4b	R2 QR A

However, as only seven of the eight participants from the first stimulus exploration were able to participate, no participant was assigned to order 4a.

3.2.2.1.4 Questionnaires

Participants were not asked for demographic information, details of musical training, or health conditions, as they had already provided this information in the first stimulus exploration, and little time had elapsed between the two studies. However, they were still asked to provide details of their caffeine, alcohol, and tobacco consumption, as those were more likely to be different.

3.2.2.1.5 Self-report measures

Participants were not asked to rate the music for arousal and valence, as they had already provided this information in in the first stimulus exploration.

Instead, as a means of focusing on induced (or felt) emotion, Visual Analogue Scales (VAS) were used for eight mood-related adjectives: joyful, calm, worried, guilty, angry, upset, happy, and sad (see Appendix F). Participants were asked to complete the VAS after each track.

Visual Analogue Scales have been previously been used in music and anxiety studies (such as K.-C. Lee et al., 2011; 2012; P.-C. Lin et al., 2011).

3.2.2.1.6 Chair

In response to feedback from the first stimulus exploration, and to make the environment more conducive to relaxation, a more comfortable, padded chair was used, positioned so that the participant was not facing the researcher.

3.2.2.1.7 Participants

All participants from the initial stimulus exploration were invited to take part in this follow-up study. Only one participant (female, age 25) was unable to attend. As such, only seven of the eight orders were used.

3.2.2.2 Results

As with the first study, this was an exploratory study, with a small sample size (n = 7) and a number of different orders (four different arrangements of anxious music, relaxing music, and quiet rest, and alternation of relaxing stimulus within those orders). As such, inferential statistics were not carried out.

The results are reported as case studies. Pulse rate is explored, as in the first stimulus exploration. Participants' mood ratings are also given in full, and the two most relevant items, calm and worried, are explored in more detail.

3.2.2.2.1 Case studies

Participants' ID numbers correspond with their ID numbers from the first stimulus exploration. As such, results are reported in the same order as in the first stimulus exploration, although experimental sessions were not conducted in the same order. Participant 7 was unable to take part in this follow-up experiment.

3.2.2.2.1.1 Participant 1: Order 3b (R2 R1 A)

3.2.2.2.1.1.1 Substances

Participant 1 had consumed 1 cigarette and 1 coffee in the three hours preceding the experiment.

3.2.2.2.1.1.2 Pulse rate

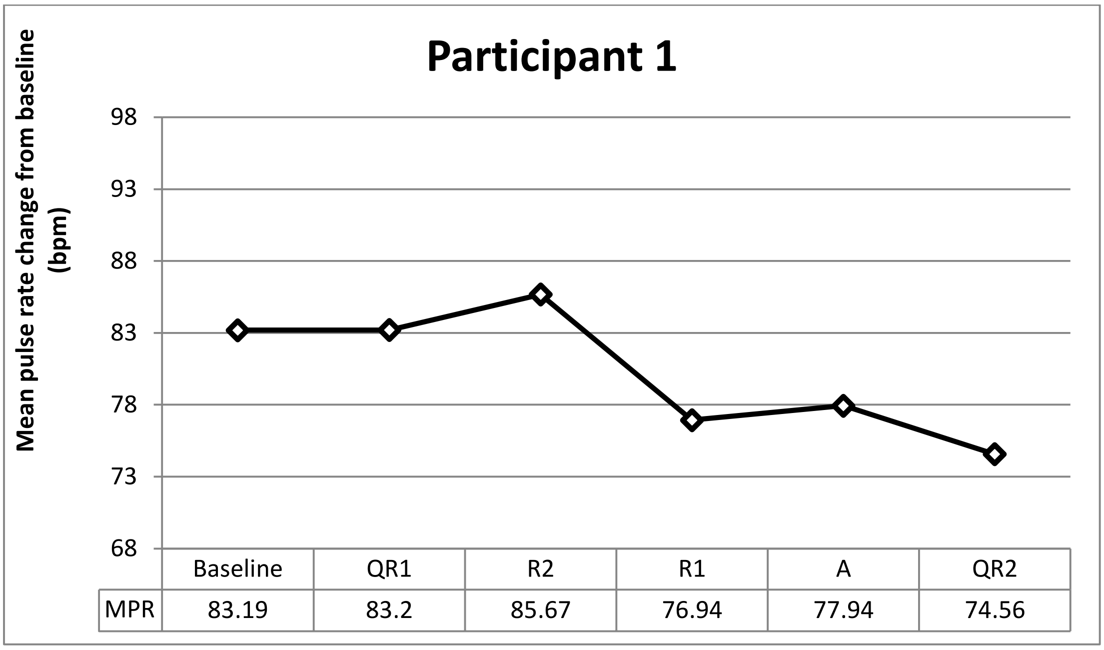


Figure 3.12: Participant 1's pulse rate

Participant 1's pulse rate results can be seen in Figure 3.12.

Participant 1's pulse rate stayed near baseline (83.19 bpm) for the first quiet rest period (83.2), rising slightly for the Saint-Saëns (85.56), and dropping further below baseline for the Chopin (76.94). It raised minutely for the Stravinsky (77.94), and dropped to its lowest point for for the final quiet rest phase (74.56).

3.2.2.2.1.1.3 Mood ratings

Table 3.19: Participant 1's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	64	91	21	9	1	1	69	8
Stage 2: after QR1								
Stage 3: after R2	74	95	4	3	2	2	64	20
Stage 4: after R1	50	97	3	4	4	4	74	21
Stage 5: after A	63	68	4	2	10	7	80	19
Stage 6: after QR2	69	95	4	2	2	2	69	19

Participant 1's mood ratings can be seen in Table 3.19. Due to experimenter error, no ratings are available for stage 2 (after the first quiet rest period). However, we can see that her worried rating went down between baseline and after the Saint-Saëns, staying roughly at this level for the remainder of the session. Her calm rating increased slightly between baseline and after the Saint-Saëns, and again after the Chopin, before dropping substantially after the Stravinsky. It rose again after the second quiet rest period

3.2.2.2.1.1.4 Combined observations

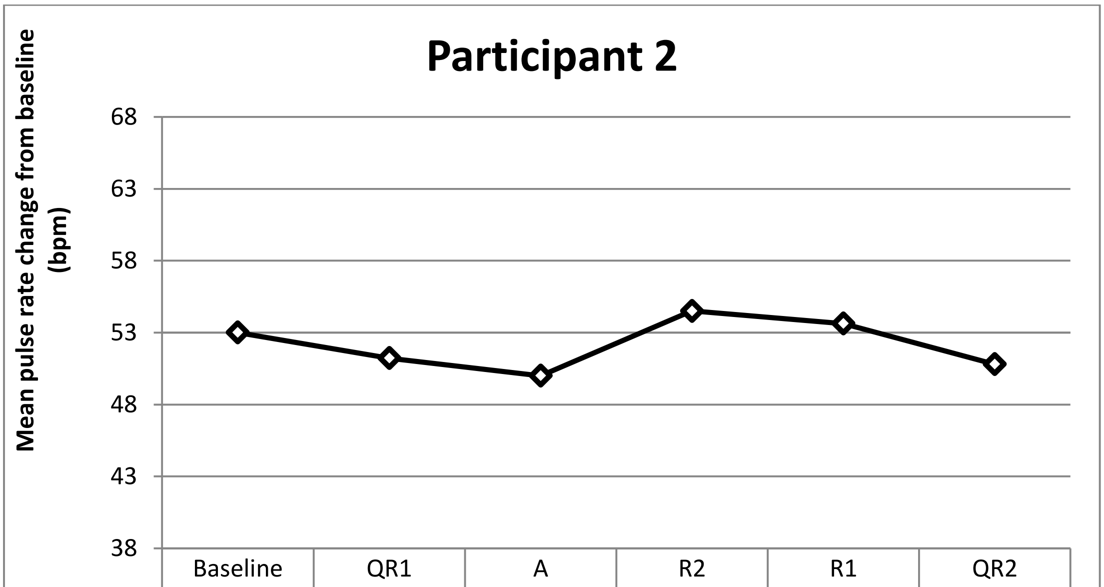
The rise in pulse rate for the anxious stimulus matched with the drop in calm ratings.

3.2.2.2.1.2 Participant 2: Order 1b (A R2 R1)

3.2.2.2.1.2.1 Substances

Participant 2 had consumed 1 coffee in the three hours preceding the experiment.

3.2.2.2.1.2.2 Pulse rate



	Baseline	QR1	A	R2	R1	QR2
MPR	53.01	51.23	50	54.51	53.63	50.8

Figure 3.13: Participant 2's pulse rate

Participant 2's pulse rate results can be seen in Figure 3.13. At baseline, her pulse rate was 53.01 bpm, dropping in the first quiet rest period (to 51.23) and the Stravinsky (50). It rose for the Saint-Saëns (54.21), dropped slightly (near baseline, to 53.63), with the Chopin, and dropped back down in the final quiet rest period (to 50.8).

3.2.2.2.1.2.3 Mood ratings

Table 3.20: Participant 2's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	78	64	69	8	8	6	89	0
Stage 2: after QR1	85	77	73	11	11	0	88	0
Stage 3: after A	73	73	73	0	0	0	85	0
Stage 4: after R2	95	81	66	0	0	0	97	0
Stage 5: after R1	90	86	50	0	0	0	98	0
Stage 6: after QR2	96	70	68	0	0	0	91	0

Participant 2’s mood ratings can be seen in Table 3.20.

Participant 2’s worried rating did not rise between quiet rest and the Stravinsky. However, it did drop after the Saint-Saëns, and again for the Chopin. It rose again after the final quiet rest period. The calm rating rose after the quiet rest phase, and dropped slightly after the Stravinsky, before rising for the Saint-Saëns and again for the Chopin. It dropped again after the final quiet rest period.

3.2.2.2.1.2.4 Combined observations

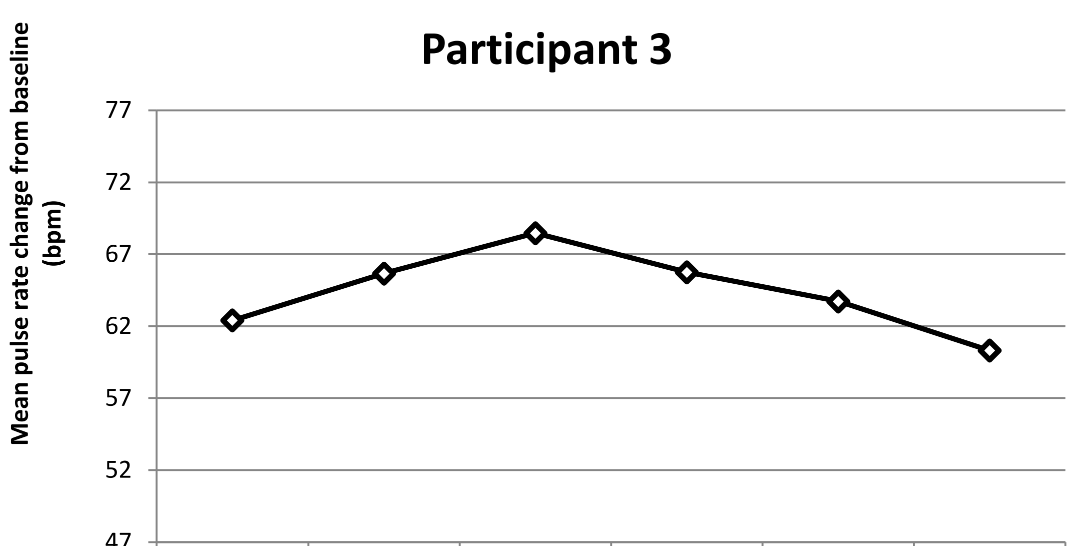
For participant 2, the mood ratings did not seem to match the physiological responses, especially with reference to the first two stimuli, where pulse rate dropped for the anxious stimulus and rose for the relaxing one, where the mood ratings suggested increased worry and reduced calm for the anxious stimulus and increased calm and reduced worrying for the first relaxing one.

3.2.2.2.1.3 Participant 3: Order 1a (A R1 R2)

3.2.2.2.1.3.1 Substances

Participant 3 had consumed 1 tea in the three hours preceding the experiment.

3.2.2.2.1.3.2 Pulse rate



	Baseline	QR1	A	R1	R2	QR2
MPR	62.4	65.66	68.47	65.75	63.73	60.31

Figure 3.14: Participant 3's pulse rate

Participant 3's pulse rate results can be seen in Figure 3.14. At baseline, her pulse rate was 64.2 bpm, rising (to 65.66) for the first quiet rest period. Then, it rose further for the Stravinsky (to 68.47). It lowered (to 65.7) for the Chopin, and further (to 63.73) for the Saint-Saëns, lowering below baseline (to 60.31) for the final quiet rest period.

3.2.2.2.1.3.3 Mood ratings

Table 3.21: Participant 3's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	70	44	64	8	34	18	51	16
Stage 2: after QR1	62	64	17	8	16	11	63	7
Stage 3: after A	25	16	12	11	21	20	59	8
Stage 4: after R1	67	76	15	14	8	8	60	5
Stage 5: after R2	65	94	3	3	7	5	82	3
Stage 6: after QR2	60	89	5	4	6	7	78	4

Participant 3's mood ratings can be see in Table 3.21.

Participant 3's worried rating was quite high after baseline, but dropped after the quiet rest phase. It dropped a small amount after the Stravinsky, rose very slightly after the Chopin, and then dropped further after the Saint-Saëns. It stayed roughly the same after the final quiet rest phase. The calm rating dropped quite substantially after the Stravinsky and rose substantially after the Chopin, and again after the Saint-Saëns, before dropping slightly after the final quiet rest phase.

3.2.2.2.1.3.4 Combined observations

For participant 3, the pulse rate reactions rose for the anxious stimulus and dropped for the relaxing stimulus, as expected. The calm ratings behaved in a similar way, but the worried ratings did not.

3.2.2.2.1.4 Participant 4: Order 2b (A QR R2)

3.2.2.2.1.4.1 Substances

Participant 4 reported consuming no alcohol, caffeine, or tobacco in the three hours preceding the experiment.

3.2.2.2.1.4.2 Pulse rate

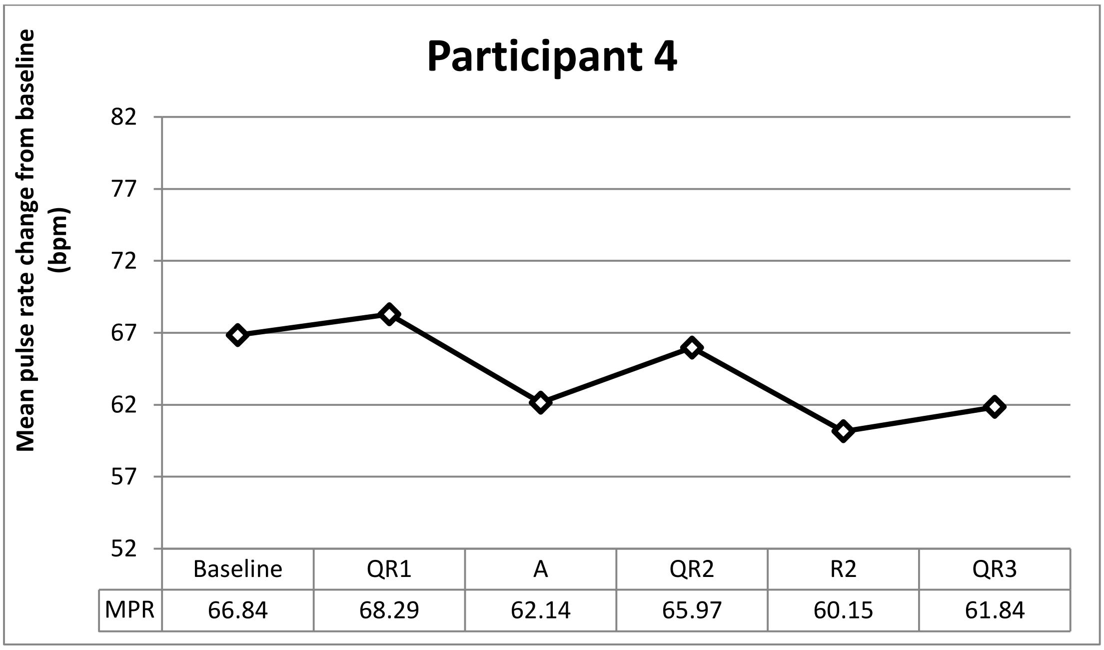


Figure 3.15: Participant 4's pulse rate

Participant 4's pulse rate results can be seen in Figure 3.15. His pulse rate was 66.84 bpm at baseline, increasing (to 68.29) for the first quiet rest period. It reduced (to 62.14) for the Stravinsky, increased (to 65.97) for the second quiet rest period, and reduced (to 60.15) for the Saint-Saëns, increasing slightly (to 61.84) for the final quiet rest period.

3.2.2.2.1.4.3 Mood ratings

Table 3.22: Participant 4's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	48	77	1	0	0	0	49	50
Stage 2: after QR1	47	89	0	0	0	0	51	49
Stage 3: after A	47	40	15	0	0	0	49	48
Stage 4: after QR2	49	79	0	0	0	0	52	51
Stage 5: after R2	47	79	3	0	0	0	49	48
Stage 6: after QR3	48	79	0	0	0	0	51	49

Participant 4's mood ratings can be see in Table 3.22.

Participant 4's worried rating was fairly low throughout, but did increase after the Stravinsky, dropping again after the middle quiet rest phase. The calm rating dropped after the Stravinsky, and rose again after the middle quiet rest phase.

3.2.2.2.1.4.4 Combined observations

For participant 4, the two mood ratings explored (worried and calm) did match, but these did not match with the pulse rate measure.

3.2.2.2.1.5 Participant 5: Order 4b (R2 QR A)

3.2.2.2.1.5.1 Substances

Participant 4 reported consuming no alcohol, caffeine, or tobacco in the three hours preceding the experiment.

3.2.2.2.1.5.2 Pulse rate

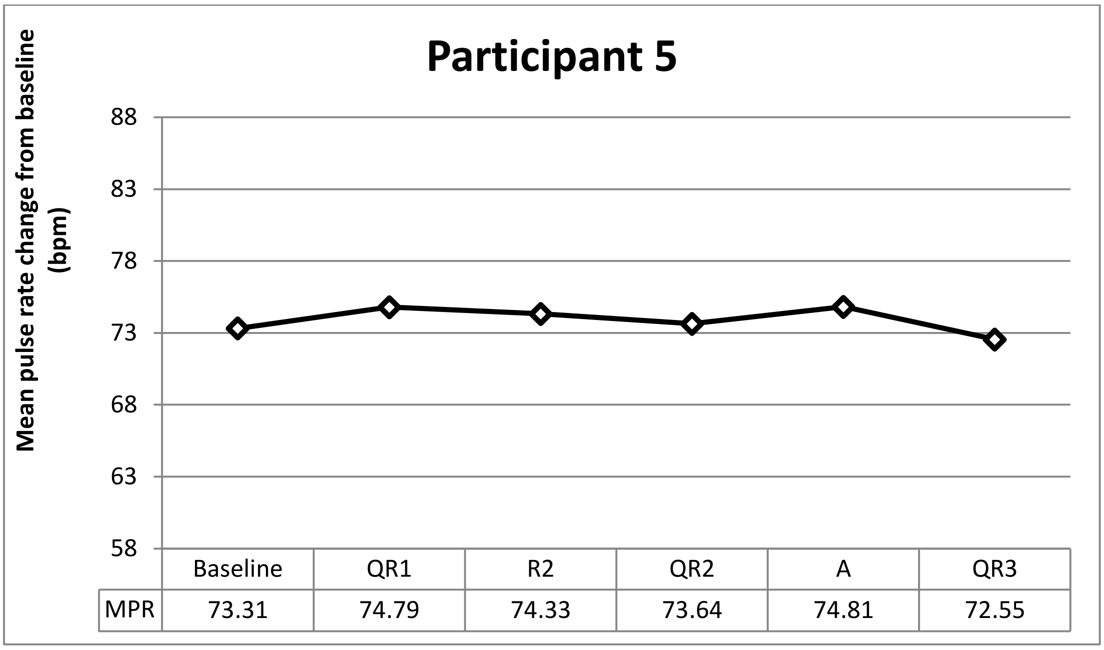


Figure 3.16: Participant 5's pulse rate

Participant 5's pulse rate results can be seen in Figure 3.16. Her pulse rate was 69.73 bpm at baseline, lowering (to 66.21) for the first quiet rest period. It lowered further during the Chopin (to 62.73) and the Saint-Saëns (to 61.74), rising slightly for the Stravinsky (to 62.34), and lowering for the final quiet rest period (to 59.2).

3.2.2.2.1.5.3 Mood ratings

Table 3.23: Participant 5's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	69	94	13	3	2	3	74	13
Stage 2: after QR1	79	96	8	3	3	3	80	7
Stage 3: after R2	26	92	23	3	3	3	35	71
Stage 4: after QR2	67	95	12	3	3	3	74	28
Stage 5: after A	78	79	5	3	3	7	83	6
Stage 6: after QR3	80	91	7	2	2	7	68	19

Participant 5's mood ratings can be seen in Table 3.23.

Participant 5’s worried rating went up after the Chopin, then down for the middle quiet rest phase, and for the Stravinsky. The calm ratings were fairly high throughout. The most noticeable drop was after the Stravinsky.

3.2.2.2.1.5.4 Combined observations

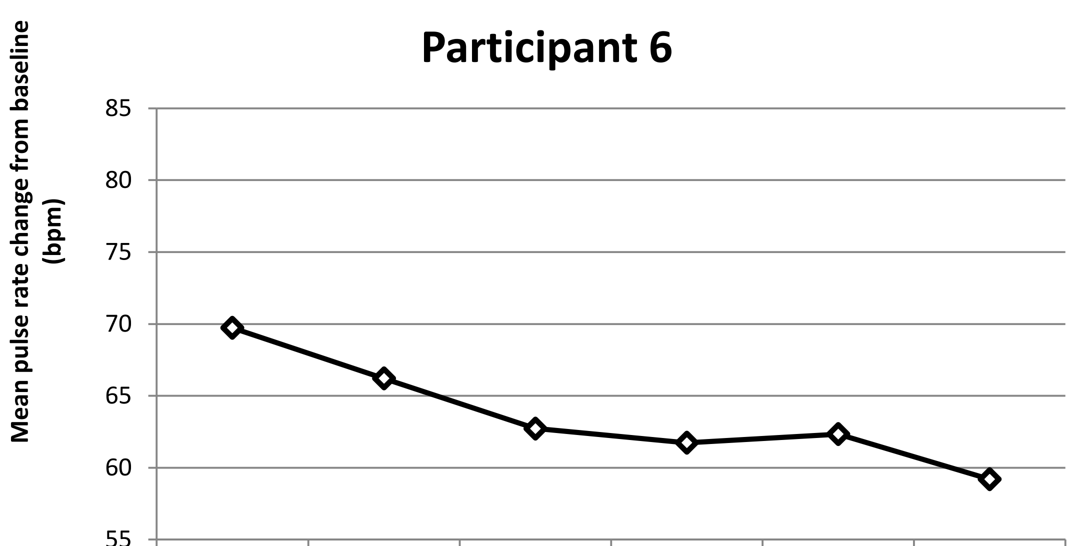
For participant 5, most changes were fairly small, and there do not seem to be many similarities between them, apart from the small increase in pulse rate for the anxious stimulus and the drop in calm ratings.

3.2.2.2.1.6 Participant 6: Order 3a (R1 R2 A)

3.2.2.2.1.6.1 Substances

Participant 6 reported having consumed 1 tea in the three hours preceding the experiment.

3.2.2.2.1.6.2 Pulse rate



	Baseline	QR1	R1	R2	A	QR2
MPR	69.73	66.21	62.73	61.74	62.34	59.2

Figure 3.17: Participant 6's pulse rate

Participant 6’s pulse rate can be seen in Figure 3.17. Her pulse rate was 69.73 bpm at baseline, lowering (to 66.21) for the first quiet rest period, for the Chopin (to 62.73), and the Saint-Saëns (to 61.74). Her pulse rose (to 62.34) for the Stravinsky, and lowered (to 59.2) for the final quiet rest period.

3.2.2.2.1.6.3 Mood ratings

Table 3.24: Participant 6's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	57	100	1	1	0	1	66	1
Stage 2: after QR1	51	100	0	1	1	1	67	0
Stage 3: after R1	91	100	0	0	0	0	89	0
Stage 4: after R2	84	100	0	0	0	0	76	0
Stage 5: after A	44	36	6	1	0	6	53	1
Stage 6: after QR2	65	85	5	0	1	0	59	6

Participant 6's mood ratings can be seen in Table 3.24.

Participant 6's worried ratings were very low throughout, although they rose slightly after the Stravinsky. Calm ratings were very high throughout, apart from after the Stravinsky, where they plummeted.

3.2.2.2.1.6.4 Combined observations

For participant 6, the physiological differences were much smaller than the changes in mood ratings, which were very large. However, they did follow a similar trend.

3.2.2.2.1.7 Participant 8: Order 2a (A QR R1)

3.2.2.2.1.7.1 Substances

Participant 8 consumed half a glass of alcohol (champagne) in the three hours preceding the experiment.

3.2.2.2.1.7.2 Pulse rate

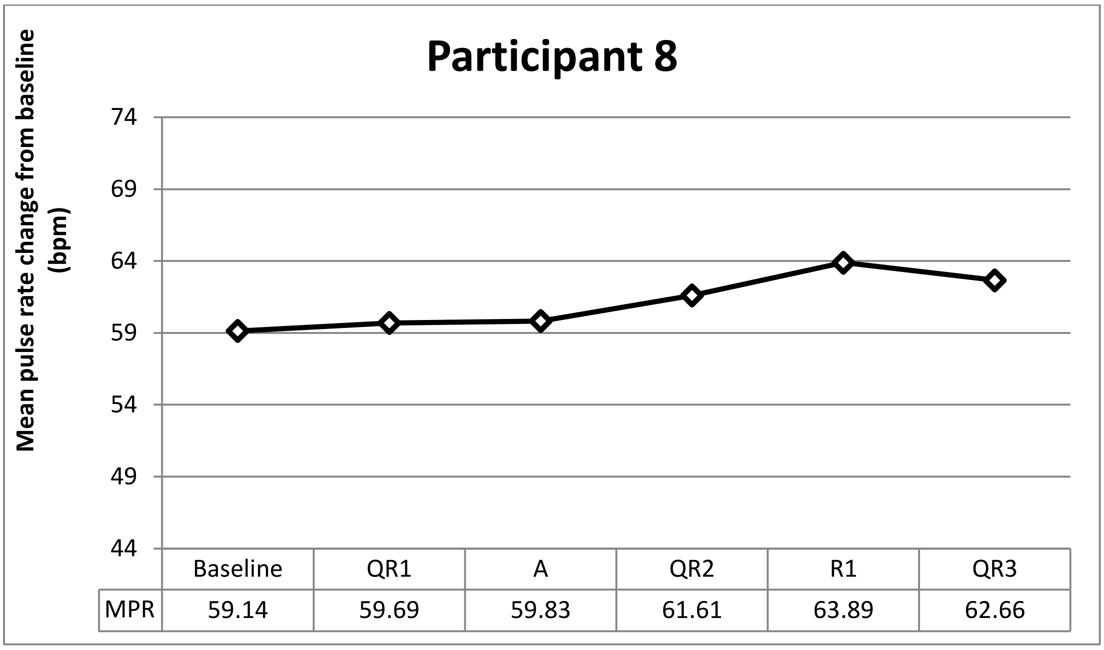


Figure 3.18: Participant 8's pulse rate

Participant 8's pulse rate results can be seen in Figure 3.18. Her pulse rate was 59.14 bpm at baseline, rising (to 59.69) for the first quiet rest period, and (to 59.83) for the Stravinsky. It rose again (to 61.61) for the second quiet rest period, and again (to 63.89) for the Chopin, and lowered (to 62.66) for the final quiet rest period.

3.2.2.2.1.7.3 Mood ratings

Table 3.25: Participant 8's mood ratings

	joyful	calm	worried	guilty	angry	upset	happy	sad
Stage 1: after baseline	15	74	73	51	19	17	17	30
Stage 2: after QR1	17	85	10	10	9	10	24	21
Stage 3: after A	42	32	24	23	23	23	44	29
Stage 4: after QR2	30	44	33	34	34	34	25	19
Stage 5: after R1	72	78	21	16	15	11	68	14
Stage 6: after QR3	49	80	59	52	26	19	54	17

Participant 8's mood ratings can be seen in Table 3.25.

Participant 8's worried rating dropped a lot after the first quiet rest phase, rose for the Stravinsky, rose further after the quiet rest phase, and dropped again after the Chopin. The calm rating dropped a lot after the Stravinsky, increased slightly after the quiet rest phase, and increased a lot after the Chopin.

3.2.2.2.1.7.4 Combined observations

For participant 8, both calm and worried ratings showed a reaction to the first (anxious) stimulus, and pulse rate to a lesser extent. Pulse rate and the worried rating rose after the following quiet rest phase, although so did the calm rating (but the difference here was small compared to other changes in this rating).

3.2.2.3 Discussion

3.2.2.3.1 Trends

Trends for pulse rate and mood ratings are reported in Table 3.26.

3.2.2.3.1.1 Anxious stimulus presented first

When the anxious stimulus was presented first, pulse rate rose for this stimulus in 2 of 4 participants, calm rating dropped in 4 of 4 participants, and worried rating dropped in 2 of 4 participants.

For those participants who heard a relaxing stimulus after the anxious track, pulse rate dropped for 1 of 2, calm rating rose for 2 of 2, and the worried rating dropped for 1 of 2 participants.

For those participants who had a quiet rest period after the anxious track, pulse rate dropped for neither participant, calm rating rose for both participants, and worried rating rose for 1 of 2.

3.2.2.3.1.2 Relaxing stimulus presented first

When the relaxing stimulus was presented first, pulse rate and worried rating rose and calm rating dropped for this stimulus for 1 of 3 participants.

For those participants who heard a second relaxing stimulus immediately following the first one, pulse rate dropped for 2 of 2 participants, calm rating rose for 1 of 2 participants, and worried rating dropped for 1 of 2 participants.

For the one participant who had a quiet rest period after the initial relaxing stimulus, their pulse rate and worried rating dropped, and their calm rating rose.

3.2.2.3.2 Observations

In the previous stimulus exploration, pulse rate rose relatively consistently in reaction to the anxious stimulus when it was presented first, and dropped for the following relaxing stimulus. This follow-up stimulus exploration explored this further, to see whether the drop in pulse was attributed to the lack of anxious stimulus or the presence of a relaxing stimulus.

In this stimulus exploration, pulse rate and worried rating only increased in 2 of 4 participants when the anxious stimulus was presented first, which does not indicate a consistent response to the anxious stimulus, but calm rating dropped for all participants.

As such, the calm rating is of particular interest when examining the response to the period following the anxious stimulus. For the two participants who heard a relaxing stimulus next, calm rating rose, which matched expectations. Calm rating also rose for the two participants who experienced a quiet rest period next, indicating that this calm rating may have changed in response to the removal of the anxious stimulus. The worried rating dropped for 1 of 2 participants in both orders (anxious then relaxing, and anxious then quiet rest). But a difference in pulse rate was identified, with pulse rate dropping for 1 of 2 participants who heard the relaxing stimulus after the anxious stimulus, and for neither of the participants who had a quiet rest period after the anxious track.

Although the response to the anxious stimulus was inconsistent, there does appear to be a difference when the relaxing stimulus was presented first, with increased pulse rate and worried rating and decreased calm rating only visible in one of three participants. As such, it appears that participants did react with increased physiological arousal and worried rating, and decreased calm, in reaction to the anxious stimulus in comparison to the relaxing stimulus, when they were presented first.

For participants who heard a second relaxing stimulus immediately after the first one, pulse dropped for both participants, and calm rating rose and worried rating dropped for 1 of 2 participants. For the one participant who had a quiet rest period after the stimulus, pulse rate and worried rating dropped, and calm rating rose. This pattern was consistent with what was expected for when the anxious stimulus was heard first, and it is possible that this indicates that the anxious stimulus was not effective enough at increasing physiological arousal and worried rating.

The main trends of interest in this stimulus exploration were the initial reaction to the anxious stimulus, and the response to the following phase (whether relaxing music or quiet rest).

Pulse rate only rose for two of the four participants who heard the anxious stimulus first (compared with one of three when a relaxing stimulus was heard first). However, the calm rating dropped for all four (anxious stimulus first), compared to one of three (relaxing stimulus first) dropping very slightly. The worried rating rose for two of the four participants who heard the anxious stimulus first, while this happened for only one of three who heard a relaxing stimulus first.

Although all participants reported being less calm after the anxious stimulus, their pulse rate and worried ratings were not greatly different than those who heard the relaxing stimulus first.

For the second phase, where the anxious stimulus was first, pulse rate dropped for one of two participants who heard a relaxing stimulus, and for neither of the two participants who had quiet rest. Calm ratings rose for both of the participants who heard a relaxing stimulus, and both of those who had quiet rest. Worried ratings dropped for one of two participants in each of the relaxing and quiet rest periods.

The worried and calm rating trends suggest that listening to music did not have much more of a relaxing effect than a quiet rest phase after the anxious stimulus. However, as the response to the anxious stimulus was inconsistent, apart from an increase in calm rating which was shared by all participants who heard it first, this should be explored further.

Findings from this study showed that the anxious music stimulus did not consistently increase physiological arousal. However, it did so more than a relaxing stimulus, when it was presented first.

In the two examples where pulse rate did rise for the initial anxious stimulus, it went down again for the relaxing piece for one participant, and up for the quiet rest in the other participant.

3.2.2.3.3 Limitations

As in the first stimulus exploration, trends should be interpreted cautiously. Rather than findings in themselves, they should be consider a means of informing future stages.

The large number of orders could be seen as a limitation, as they hindered observation of multiple participants' responses to the same situation. However, the different orders were in place as an exploratory tool, to discover what in particular should be followed up in step 3, and in this way they were effective.

Evaluation of the mood scales used suggested that it may be useful to choose a standardised scale that can give a single score for the pilot and analogue study.

3.2.2.3.4 Direction

From this stimulus exploration, it was concluded that further development should include the artificial anxiety induction to be used in the analogue study. The larger aim of the experimental work in this thesis is to examine music listening in response to an anxiety-inducing situation which contains both the elements of worry and physiological arousal associated with anxiety disorders. As such, the next step involved the development and evaluation of an anxiety induction protocol which fulfilled these critera, and to test listening to optimal music during this protocol.

A larger study, using parallel design is needed, with minimal differences in experimental procedure, to be able to more fully review the effect of music listening on anxiety reduction. This protocol was developed in a pilot study.

Table 3.26: Pulse rate and mood trends

		Orders 1a/1b		Orders 2a/2b		Orders 3a/3b		Order 4b	
Order	**Pulse rate trend**	**P3**	**P2**	**P8**	**P4**	**P6**	**P1**	**P5**	**Total**
A first	**Pulse rises for A**	Yes	No	Yes	No	N/A	N/A	N/A	2 of 4
	Calm drops for A	Yes	Yes	Yes	Yes	N/A	N/A	N/A	4 of 4
	Worried rises for A	No	No	Yes	Yes	N/A	N/A	N/A	2 of 4
A then R	**PR drops for R after A**	Yes	No	N/A	N/A	N/A	N/A	N/A	1 of 2
	Calm rises for R after A	Yes	Yes	N/A	N/A	N/A	N/A	N/A	2 of 2
	Worried drops for R after A	No	Yes	N/A	N/A	N/A	N/A	N/A	1 of 2

		Orders 1a/1b		Orders 2a/2b		Orders 3a/3b		Order 4b	
A then QR	**PR drops for QR after A**	N/A	N/A	No	No	N/A	N/A	N/A	0 of 2
	Calm rises for QR after A	N/A	N/A	Yes	Yes	N/A	N/A	N/A	2 of 2
	Worried drops for QR after A	N/A	N/A	No	Yes	N/A	N/A	N/A	1 of 2
R first	**PR rises for first R**	N/A	N/A	N/A	N/A	No	Yes	No	1 of 3
	Calm drops for first R	N/A	N/A	N/A	N/A	No	No	Yes	1 of 3
	Worried rises for first R	N/A	N/A	N/A	N/A	No	No	Yes	1 of 3
R then	**PR drops for R**	N/A	N/A	N/A	N/A	Yes	Yes	N/A	2 of 2

		Orders 1a/1b		Orders 2a/2b		Orders 3a/3b		Order 4b	
R	**after R**								
	Calm rises for R after R	N/A	N/A	N/A	N/A	No	Yes	N/A	1 of 2
	Worried drops for R after R	N/A	N/A	N/A	N/A	No	Yes	N/A	1 of 2
R then QR	**PR drops for QR after R**	N/A	N/A	N/A	N/A	N/A	N/A	Yes	1 of 1
	Calm rises for QR after R	N/A	N/A	N/A	N/A	N/A	N/A	Yes	1 of 1
	Worried drops for QR after R	N/A	N/A	N/A	N/A	N/A	N/A	Yes	1 of 1

3.3 Anxiety induction pilot

This pilot study was conducted as a means of trialling a protocol for an analogue, proof-of-concept study, to be conducted within a general population. The aims were 1) to develop and evaluate an anxiety induction procedure that includes both the elements of physiological arousal and worry which characterise anxiety disorders; 2) to evaluate two separate music stimuli, and their effectiveness at reducing anxiety versus a white noise stimulus. This pilot also provided an opportunity to test other methods, such design, questionnaires, and measures.

3.3.1 Changes from stimulus explorations

This introduction will outline a number of key changes from the stimulus explorations. The methods will then be outlined more fully in Section 3.3.2.

3.3.1.1 Changes in design and participants

Regarding design, the pilot was designed as a parallel (between-subjects) randomised control trial (RCT). This design was chosen as the best means of isolating the effect of music.

The pilot had 15 participants, in anticipation of a larger sample size in the analogue, proof-of-concept study.

3.3.1.2 Changes in stimuli

The results from the first stimulus exploration suggested that both ‘relaxing’ stimuli were rated as inducing positive valence and low arousal. To further verify the appropriateness of the stimulus inclusion criteria in the pilot study, the stimulus chosen via the rating study (‘The Swan’) was compared with another stimulus from the literature, specifically a stimulus from a paper by Eerola and Vuoskoski (2011), that strove to systematically evaluate the emotional effects of music, to facilitate their use in music psychology studies (for more information, see Section 2.2.2).

Because I was interested in examining how the piece selected using the rating exercise and the previously defined criteria (see Section 3.1) matched up to one identified by Eerola and Vuoskoski, The Saint-Saëns piece (‘The Swan’) was kept, and the Chopin (*Nocturne*) was replaced. In addition, ‘The Swan’ was rated as better liked, and inducing more positive affect and reduced arousal than *Nocturne* in the first stimulus exploration (see Section 3.2.1).

White noise was chosen as the control stimulus (instead of silence), and has been used previously in music listening studies (such as Mitchell & MacDonald, 2006). White noise ensures an element of auditory stimulation. It also provided a reason to give the participant headphones, which made the conditions more similar than otherwise.

3.3.1.3 Changes in measures

Visual analogue scales for various mood adjectives were used in the second stimulus exploration. From this, two were identified as particularly relevant: calm and worried. As both of these adjectives relate to anxiety, a standardised subjective anxiety scale was used for the pilot study.

Subjective anxiety was measured using the short form of the state scale of the State-Trait Anxiety Inventory (STAI-SF), which has previously been used in RCTs measuring the effect of music listening on anxiety (such as Chlan, 1998; Nguyen, Nilsson, Hellström, & Bengtson, 2010; S. Nilsson et al., 2009a), adapted from Spielberger's (1983) full STAI by Marteau and Bekker (1992).

3.3.1.4 Anxiety induction

One of the main aims of this pilot was to develop and evaluate an anxiety induction protocol which accurately modelled clinical anxiety (and as such induced both physiological arousal and worry). The protocol used was adapted from the Trier Social Stress Test, which requires the participant to prepare a presentation for a mock job interview, give the presentation in front of an intimidating panel, and then answer questions (Kirschbaum et al., 1993). A simpler version of this was used by Knight and Rickard (2001) in their music listening study, as discussed in Section 2.3.5, and indeed their protocol was similar to that used in this pilot.

3.3.2 Methods

3.3.2.1 Design

This pilot study took the form of a parallel (between-subjects) randomised control trial (RCT). Participants were randomised into one of three stimulus conditions: music 1, music 2, or white noise, with the latter being the control condition. Randomisation was determined by Random.org's List Randomiser.[11] An equal number of participants were randomised to each condition. The randomisation was single blinded, meaning that the experimenter knew which conditions participants had been assigned to, but that the participants themselves did not. Participants were not informed that the listening phase was of particular interest to the experimenter, and were not aware that other participants may have had different listening stimuli. There was no double blinding, because it was necessary for the experimenter to select the appropriate stimulus during the experiment. The experimenter followed a script to maximise consistency and ensure the protocol was followed correctly.

The study protocol was approved by the ethics committee for the School of Health in Social Science at the University of Edinburgh.

3.3.2.2 Participants

Participants were recruited through an advertisement in the online careers portal at the University of Edinburgh, which framed the experiment as a "mental visualisation study".

15 participants took part in the study (5 music 1, 5 music 2, 5 white noise). However, participant 1was excluded from subjective anxiety analyses, due to experimenter error. Thus, the final sample size for subjective anxiety was 14 (5 music 1, 4 music 2, 5 white noise). Within these participants, the average age was 20.5 (*SD* = 1.29, range = 19-23). 4 of the participants were male (28.6%), and 10 were female (71.4%). Participants 1 and 2 were excluded from pulse rate analyses, as they experienced a

[11]http://www.random.org/lists/

longer version of the study[12] (see section 5.1.1.9). As such, the final sample size for pulse rate was 13 (4 music 1, 4 music 2, 5 white noise). Within these participants, the average age was 20.46 (*SD* = 1.33, range = 19-23). 4 of the participants were male (30.8%), and 9 were female (69.2%).

3.3.2.3 Stimuli

Musical stimuli were chosen to comply with a set of criteria that were synthesised from music psychology literature. These criteria were chosen to identify music that would be optimal at reducing anxiety by promoting positive valence and reducing physiological arousal. Music with features associated with high valence and low arousal can serve the dual purpose of increasing the effectiveness of a relaxation technique, and promoting a positive affective response to combat negative mood and thus reduce perseverative worry. Previous studies have shown that music categorised as positive valence and low arousal (and therefore optimal for promoting positive affect and decreased physiological arousal) is associated with quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

3.3.2.3.1 Music 1

The first music stimulus was a combination of two partial tracks from *Pride and Prejudice*, by Dario Marianelli (Decca Records, 2005). The tracks were entitled 'Dawn' and 'The Secret'. Segments of these tracks were identified as low arousal and high valence in Eerola and Vuoskoski's study (2011) and they also met with the previously-defined criteria for relaxing music.[13] The segments were cut and combined using the audio editing software, Audacity.[14]

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[12] As participant 1's subjective anxiety results did not change in the additional phase of the study, her results were still included in the subjective anxiety analyses.

[13] Slow tempo, consonant harmony, quiet dynamic, no sudden changes, simple rhythm, major tonality.

[14] http://audacity.sourceforge.net/

3.3.2.3.2 Music 2

The second music stimulus was ‘The Swan’ from *Carnival of the Animals*, by Camille Saint-Saëns. The stimulus selection process for this stimulus is outlined in Section 3.1, and two exploratory studies using this stimulus, alongside a *Nocturne* by Chopin, are reported in Section 3.1

3.3.2.3.3 White noise

The control stimulus was white noise.[15] To ensure the experimental conditions were as similar as possible, all stimuli were cut to 3 minutes and 44 seconds in length. Best efforts were made to ensure these cuts were made in appropriate places within the music.

3.3.2.4 Measures

3.3.2.4.1 Subjective anxiety

Subjective anxiety was measured using the short form of the state scale of the State-Trait Anxiety Inventory (STAI-SF).

This measure was developed and evaluated by Marteau and Bekker (1992) and was found to be an acceptable substitution for the full STAI ($r > .90$, $\alpha = .82$). The STAI-SF was introduced to the participants as a mood questionnaire, rather than an anxiety questionnaire, to minimise response bias.

While the state (or situational) anxiety section of the original STAI has 20 items (Spielberger, 1983), this short form has six items, and one overall state anxiety score. As such, it is particularly suited to intervention testing, where quick responses are needed. The items consist of the following statements: 1) “I feel calm”, 2) “I am tense”, 3) “I feel upset”, 4) “I am relaxed”, 5) “I feel content”, and 6) “I am worried”. Participants are asked to rate these on a 4-point scale, for how much the item matches how the participant feels at the time of completing the questionnaire, from 1 (“Not at all”) to 4 (“Very much”). Possible scores range from 6 to 24, with 24 indicating the highest level of anxiety.

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[15] SimplyNoise's Signature White Noise, downloaded from http://simplynoise.com

Scores for the STAI-SF were calculated by reversing items 1 (calm), 4 (relaxed), and 5 (content), and adding these to the raw ratings from the other items, as recommended by Marteau and Bekker (1992).

Although this can be converted into a larger score for diagnostic purposes, in this experiment the scores were kept raw, as they were only being used for assessment of the intervention rather than a diagnosis, and for group comparisons, rather than alignment to a normal population.

3.3.2.4.2 Pulse rate

Pulse rate, in beats per minute (bpm), was measured using a transmissive infrared fingertip sensor worn on the middle fingertip of the non-dominant hand. The sensor averages pulse rate values over four seconds, with a new average calculated approximately 10 times per second. This device was produced by Nonin Medical,[16] an established manufacturer of medical devices. Data was transmitted wirelessly to a netbook, using technology developed by Mobile Healthcare Networks (MHN Ltd).[17]

For each physiological analysis window (see Section 3.3.2.7), a mean was taken of the pulse rate for each participant.

3.3.2.4.3 Questionnaires

In addition to the subjective anxiety questionnaire (STAI-SF), participants were asked to complete up to three questionnaires (depending on condition).

3.3.2.4.3.1 Music questionnaire

The music questionnaire can be seen in Appendix G. This was given to the participants who listened to a musical stimulus (music 1, and music 2, not the white noise group), after the experimental condition and final mood scale. The music questionnaire asked participants how much they liked the music, how familiar they were with the music, whether they had any particular associations with the music,

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[16] http://www.nonin.com/index.aspx

[17] http://www.mobilehealthcarenetworks.com/index.html

what those were, and whether they were positive or negative. It also asked whether the participant had played the music in the stimulus, and if so on what instrument.

3.3.2.4.3.2 Tasks questionnaire

The tasks questionnaire can be seen in Appendix H. This was given to all participants at the end of the experiment. This questionnaire was designed as a manipulation check, and as a way of exploring the mechanisms behind the anxiety induction. This included 9 statements, which the participants were asked to rate on a 5-point scale, from “strongly disagree” to “strongly agree”. Statements asked whether the participants generally enjoyed presentations, how they felt they’d perform in this presentation, how the mental visualisation activity made them feel, and whether or not they believed that they’d have to give a presentation.

3.3.2.4.3.3 Personal information questionnaire

The personal information questionnaire can be see in Appendix I. This was given to all participants at the end of the experiment. This questionnaire asked for personal information, including name, date of birth, and gender (male/female/other). It asked for details of any musical training (instrument and length of time played). It also asked for details of any health conditions and current treatment for those conditions. Finally, it asked whether the participant had consumed any caffeine, alcohol, tobacco, or other substances, in the 4 hours preceding the experiment.

3.3.2.5 Anxiety induction

The protocol used in this pilot involved the participant being informed that they would have to give a presentation to other experiment participants. While they waited for the presentation time, they were given a mental visualisation exercise (see Appendix L), which asked them to think about a previous presentation they’d done where they’d felt nervous, anxious, or stressed. This was adapted from existing rumination exercises (J. R. Brown, 2011; Kocovski, MacKenzie, & Rector, 2011), and was used to provoke negative perseverative thought in relation to the presentation.

3.3.2.6 Procedure

Because this study was a pilot, a number of tweaks were made between participants. This section details the final protocol, as it stood by the end of the pilot. Changes made will be described in Section 3.2.2.1.

3.3.2.6.1 Pre-arrival

Participants were given directions to the study location in advance. When they arrived at the appropriate floor of the building, signs directed them to a waiting area, with a final sign indicating that this was the waiting area for experiments in several rooms (see Figure 3.19). This was designed to make the participant think that other experiments were being carried out at the same time, and thus to increase the believability of the idea that they would be asked to present to other participants.

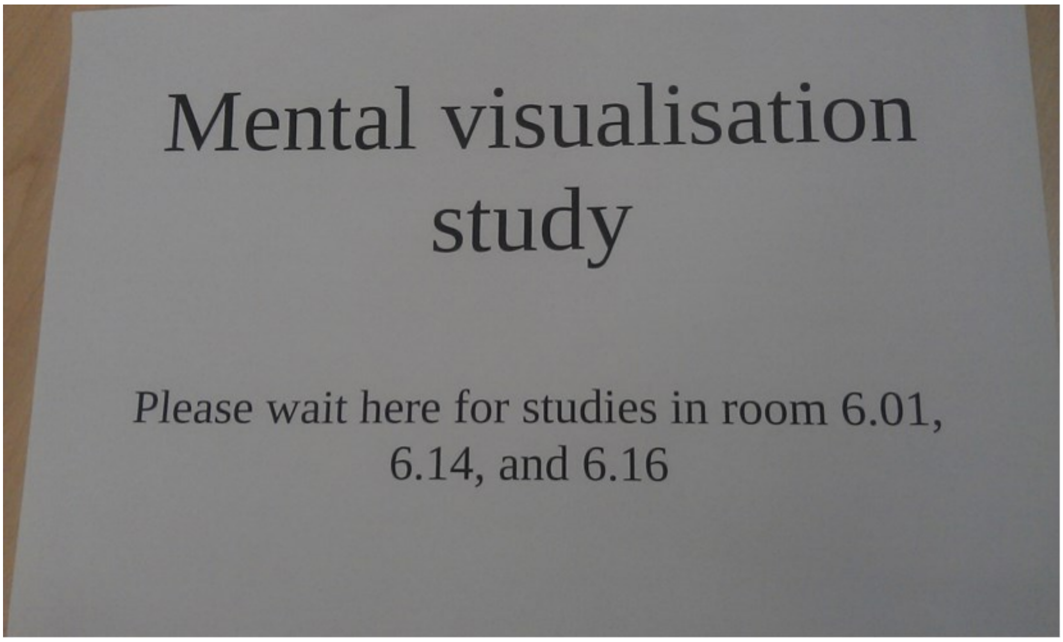


Figure 3.19: Waiting area sign

I, the experimenter, then met the participant at this waiting area, and asked which room they were waiting for. Since the extra rooms were only mentioned as a decoy, all participants were waiting for me and my room.

3.3.2.6.2 Arrival

The participant was welcomed into the room, and shown where they could put their coat, bag, and anything else they had brought. They were then invited to sit in a chair at a desk (see Figure 3.20).

Figure 3.20: Participant desk

3.3.2.6.3 Consent

Once the participant was seated, I gave them an information sheet about the study (see Appendix J). I read through the main points of the sheet, and then gave the participant time to read through the information sheet themselves. The participant was also given the opportunity to ask any questions they had.

Following this, the same procedure was applied to the consent form (see Appendix K), with me reading through the main points, and the participant having time to read it through themselves, and the opportunity to ask any questions. The participant then signed the consent form when they were happy.

3.3.2.6.4 Habituation

I then connected the participant to the pulse sensors, explaining that this would be measuring their pulse rate throughout the study. After setting up and starting the session on the pulse software, a five minute habituation period was used to give the participant's pulse rate time to recover from physical activity on the way to the study.

During those five minutes, I explained how the sensors worked, and told the participant how they should act when asked to sit quietly (to try to avoid excessive movement or speech, unless they were uncomfortable or had something important to say). They were also shown a demonstration version of the subjective anxiety scale (STAI-SF), framed to them as a mood questionnaire. I explained the questionnaire, and the participant was then given time to look over the questionnaire, and ask any questions they had. After this, the participant was asked to "sit quietly" for between 3 and 4 minutes, i.e. the remainder of the habituation period, and one minute's baseline (time 1 – pulse)

They were then asked to complete the first instance of the STAI-SF (time 1 – mood).

3.3.2.6.5 Anxiety induction

Next, the participant was told they were going to be asked to give a five minute presentation about the subject that they were studying to me, two other experimenters, and their participants. They were told that this presentation would take place in around 10 minutes. I pointed out the presentation area set up on one half of the room, with six chairs in a semi-circle, explaining that the presentations would take place in this room because of it being the largest.

The participant was told that the experimenters would be assessing the participants on a marking scheme, which the participant was then shown and given time to read through (see Appendix M). This was included to increase the sense of social evaluative threat experienced by the participants in anticipation of the presentation.

The participant was then told that, while they waited for the presentation, they would be asked to do a mental visualisation activity. I explained the activity, telling the participant that the activity asked them to think of a specific time when they had done public speaking, such as a presentation, when they had felt anxious, nervous, or stressed. The participant was told that they would have one minute to read through the exercise, and that they would then be stopped to complete a second mood questionnaire. They would then have around 4 minutes to "complete" the exercise, which involved thinking about questions, rather than giving verbal or written answers. The participant was informed that the experimenters were interested in how the mental visualisation activity affected the participants' performance in the presentation.

As described above, the participant was then given one minute to read through the activity (time 2 – pulse). They were then given a second mood questionnaire to complete (time 2 – mood).

3.3.2.6.6 Experimental condition

The participant was then told that they would now have four minutes to complete the mental visualisation activity. At this time, I gave them a set of headphones (see Figure 3.21) explaining that they were being given headphones with music/white noise (dependent on the condition the participant had been randomised to) to help them relax.

Figure 3.21: Headphones

They were then told to start the exercise. The auditory stimulus was then started immediately.

All stimuli lasted for 3 minutes and 44 seconds each (time 3 – pulse). After the end of the stimulus, the participant was told to stop working on the exercise, and was asked to take off the headphones and return them to me. They were then asked to complete the STAI-SF (time 3 – mood). If the participant had been in a music condition, they were then given a questionnaire to complete about the music.

3.3.2.6.7 Finish and debrief

At this point, the participant was asked to come and sit in a chair facing the experimenter across a table. They were then told that they would not have to do a presentation. They were informed that I had been looking at how the stressful situation had affected their mood and pulse rate. They were told that in the preparation period, some people had been given music and others had been given white noise, and that the experiment was looking at the difference in mood and pulse rate between those groups.

They were then given a tasks questionaire and a personal information questionnaire to complete. After completing these questionnaires, they were asked for verbal feedback. The participants were told that the study was a pilot, and that the experimenter was interested in what they thought. In particular, they were asked whether they had believed that they would have to give a presentation, whether they had found it stressful, and why.

Before leaving, the participant was then given a £10 voucher for Amazon UK, to thank them for participating, and asked to sign a receipt for this.

3.3.2.7 Analysis points

Pulse rate was measured continuously throughout the pilot, but there were three windows/time points used for analysis, with a mean taken of each window. A subjective anxiety questionnaire was given to the participant immediately following each of these times:

1) The initial baseline, occurring 5 minutes after the pulse sensors were connected, and lasting 60 seconds.

2) The anxiety baseline, occurring after the participant was informed that they would be asked to give a presentation, while they were first reading through the mental visualisation exercise, also lasting 60 seconds.

3) The experimental condition, occurring while the participant was completing the mental visualisation exercise, and while they were listening to the experimental stimulus (either music 1, music 2, or white noise) through headphones. This lasted 3 minutes and 44 seconds.

For pulse rate, a mean of each time period was taken.

3.3.2.8 Changes made

As this pilot was designed not only to test the effectiveness of the stimuli, but also to develop an optimal format for a larger, proof of concept study, changes were made throughout the study before arriving at the final protocol.

3.3.2.8.1 Cyberball

For the first two participants, Cyberball (a short video game, where a ball is tossed on the click of a button) was included in the protocol, after baseline. The game was set up to help the participant believe that they were playing with other experiment participants, although in reality the other players' ball tosses were pre-programmed into the computer (K. Williams, 2010).

However, verbal feedback from the first two participants strongly indicated that they did not find the game believable, and that using Cyberball made the rest of the study less believable. This feedback was so strongly worded that it was decided to remove Cyberball from the protocol for the remaining participants.

3.3.2.8.2 Public speaking task

For the first two participants, the participants were told that either they or one of the two other Cyberball participants would be asked to participate in a mock job interview. This was based on Knight and Rickard's study (2001) where participants were told there was a fifty percent chance they would be asked to do a presentation. An interview was chosen because it would require less preparation for the participants than a presentation, and it was less controllable (Dickerson & Kemeny, 2004). However, participants reported that the interview did not seem particularly believable, and that it was not very stressful. As a result, the rest of the participants were told that they would be asked to do a presentation on the subject they studied, to two other experiment participants and experimenters. Initially, they were told that this would be a two minute presentation.

To make the presentation seem more believable, a presentation area was set up in one half of the room, with the participant being told that the other participants would be coming into this room to do their presentations, because it was the largest. This presentation area was visible from the outset of the experiment, but attention was not drawn to this area until after the task was outlined to the participants, as a means of affecting baseline measurements as little as possible.

After reports that a two minute presentation was too short to seem particularly stressful, the presentation timing was extended to five minutes and a marking scheme was introduced. Subsequent participants reported verbally that they had found five minutes to be an effective amount of time: short enough to be believable within the timing of the experiment but long enough to induce stress. The marking scheme was designed to heighten the sense of social-evaluative threat, as it emphasised the fact that participants would be assessed. The last criterion asked experimenters to rate how well they felt participants would do in their degree, based on their performance in the presentation. This criterion was reported to be particularly effective in inducing stress.

3.3.2.9 Hypotheses

3.3.2.9.1 Anxiety induction

It was hypothesised that pulse rate and subjective anxiety (as per the STAI-SF) would increase between time 1 (baseline) and time 2 (anxiety baseline).

3.3.2.9.2 Music effect

It was hypothesised that the participants randomised to the music conditions (music 1 and music 2) would experience a drop in pulse rate and subjective anxiety (as per the

STAI-SF) between time 2 and 3, while the control condition (white noise) would experience no difference in these scores between these time points.

3.3.3 Results

Two of the aims of this pilot were to evaluate the effectiveness of the anxiety induction protocol and of the musical stimuli. However, due to the changes made during the experiment, and the small sample size, any analyses made are only preliminary, and serve as a precursor to the larger, proof-of-concept study (see Chapter 4). Because of the small sample size, non-parametric tests were used.

3.3.3.1 Differences between condition at each time point

3.3.3.1.1 Music 1 versus music 2

Before conducting any other analyses, Mann-Whitney U tests were run to explore the difference between music conditions on subjective anxiety scores and pulse rate at each time point.

For subjective anxiety, no significant difference was found at time 1 (p = .7, z = -.386), time 2 (p = .45, z = -.75), or time 3 (p = .8, z = -.25).

For pulse rate, no significant difference was found at time 1 (p = .77, z = -.29), time 2 (p = 1, z = 0), or time 3 (p = .77, z = -.29).

Because no significant differences between music conditions were found for either measure at any time point, music groups (music 1 and music 2) were combined for the remainder of the analyses.

3.3.3.1.2 Music versus white noise

Mann-Whitney U tests were conducted to explore the difference in subjective anxiety scores and pulse rate at each time point between those who listened to music and those who listened to white noise.

For subjective anxiety, there was no significant difference between music and white noise at time 1 (p = .83, z = -.21) or time 2 (p = .46, z = -.74). However, there was a significant difference between music and white noise at time 3 (p = .02, z = -2.29), with the music condition having lower subjective anxiety scores.

For pulse rate, there was no significant difference at time 1 (p = .14, z = .14), time 2 (p = .11, z = -1.61), or time 3 (p = .08, z = -1.76).

3.3.3.2 Effectiveness of anxiety induction

Wilcoxon Signed Ranks tests were conducted to explore the changes in subjective anxiety scores and pulse rate between time 1 and time 2 (see Figure 3.22 for subjective anxiety, and Figure 3.23 for pulse rate).

A significant difference was found between time 1 and time 2 for subjective anxiety (p = .002, z = -3.07) and pulse rate (p < .05, z =1.99), with both subjective anxiety scores and pulse rate increasing between time 1 and time 2.

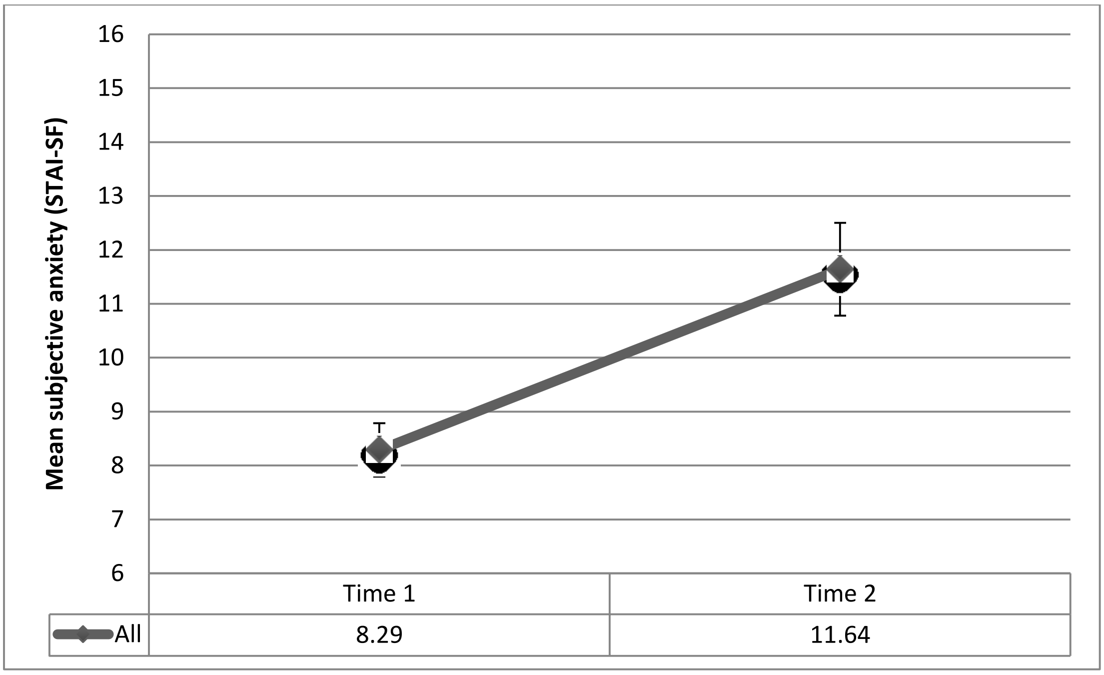


Figure 3.22: STAI-SF scores and standard error at times 1 and 2

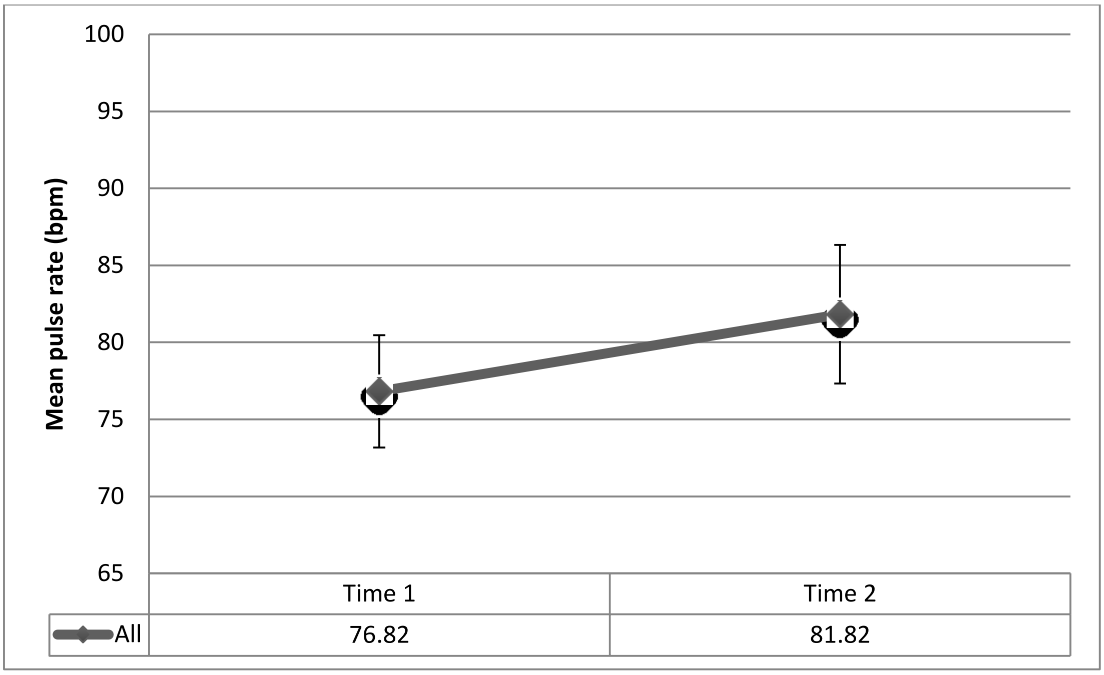


Figure 3.23: Pulse rate and standard error at times 1 and 2

3.3.3.3 Effectiveness of music versus white noise

Wilcoxon Signed Rank tests were conducted to explore the changes in subjective anxiety scores and pulse rate between time 2 and time 3, by condition (see Figure 3.24 for subjective anxiety and Figure 3.25 for pulse rate).

For those who listened to music, there was a significant decrease between time 2 and time 3 for subjective anxiety (p = .007, z = -2.68) and pulse rate (p = .01, z = -2.52).

For those who listened to white noise, there was no significant difference between time 2 and time 3 for subjective anxiety (p = .14, z = -1.47) or pulse rate (p = .67, z = -.41).

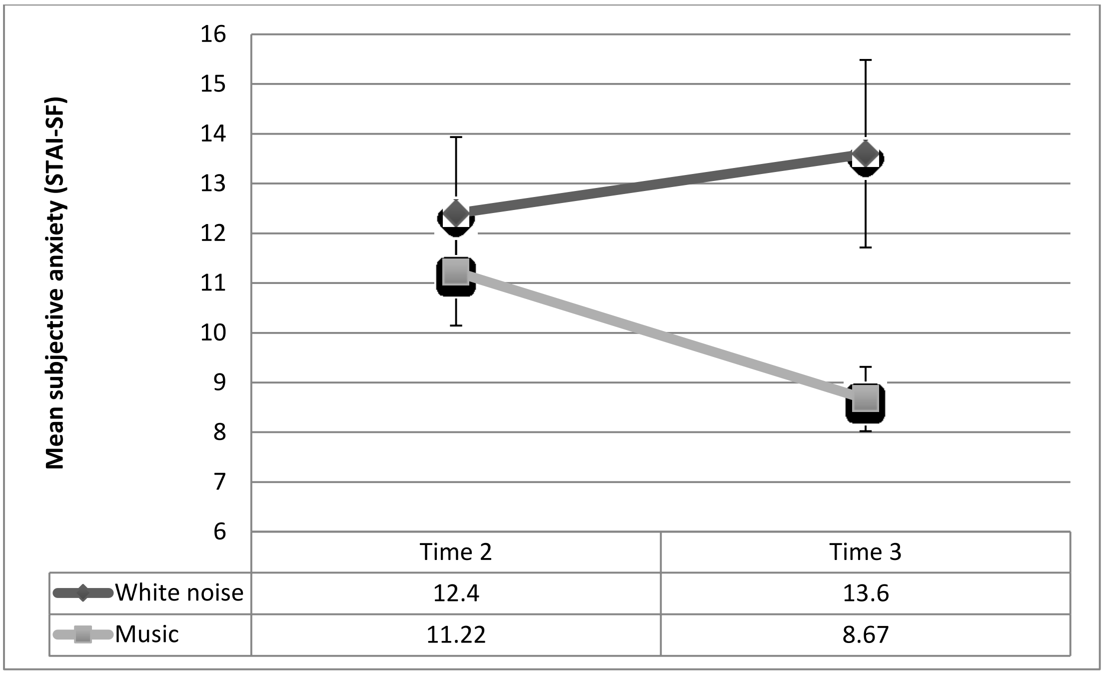


Figure 3.24: STAI-SF scores and standard error at times 2 and 3

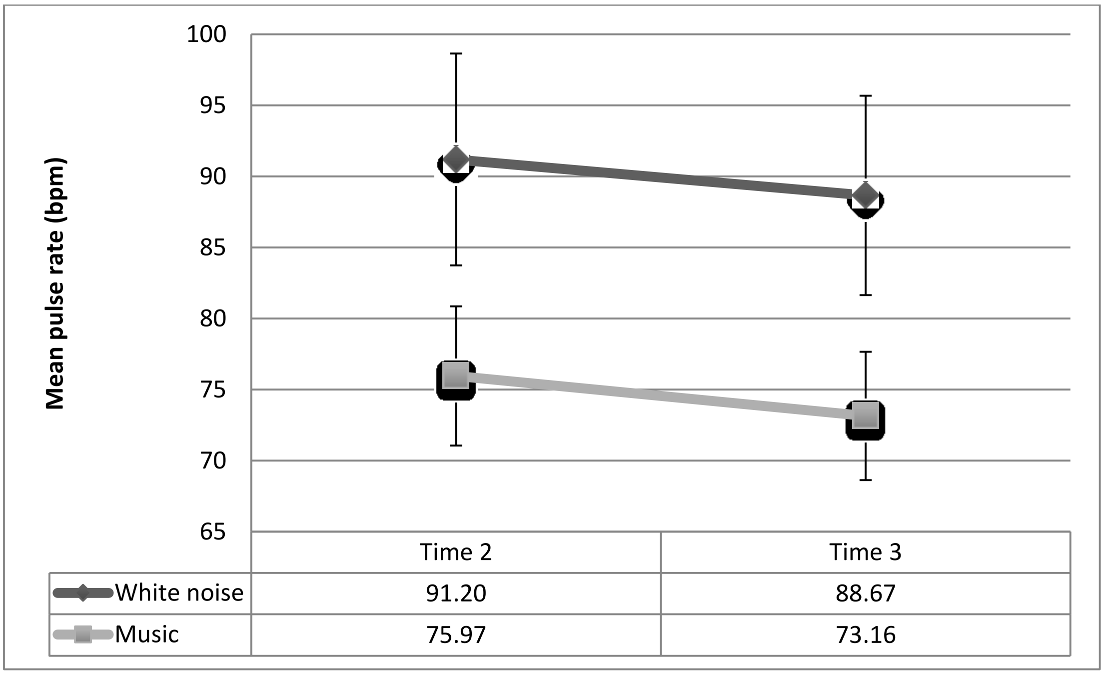


Figure 3.25: Pulse rate and standard error at times 2 and 3

3.3.3.4 Correlation between variables

Spearman's rho was used to explore the correlation between subjective anxiety scores and pulse rate. Differences from baseline were calculated for all scores at each time point, and these figures were used for correlation analyses.

At time 2, correlation was calculated for all participants using one analysis, as there had been no experimental manipulation which differed between participants at that point. There was a significant correlation (1-tailed) between subjective anxiety scores and pulse rate at time 2 ($rho = .59$, $p < .02$).

At time 3, correlations were calculated separately for music and white noise conditions. There was a significant correlation (1-tailed) between subjective anxiety scores and pulse rate for those in the music condition ($rho = .99$, $p < .001$), and those in the white noise condition ($rho = .82$, $p = .04$).

3.3.4 Discussion

No differences were found at any time point between music 1 or music 2 for subjective anxiety scores or pulse rate. As such, it seems that both music stimuli were equally effective.

Subjective anxiety scores and pulse rate were significantly higher at time 2 than time 1, suggesting that the anxiety induction protocol was effective in increasing subjective anxiety and pulse rate.

Subjective anxiety scores and pulse rate dropped significantly between times 2 and 3 for those in the music conditions, but did not change significantly for those in the white noise condition. A difference was found between the pooled music scores and white noise at time 3, with participants in the music group having lower subjective anxiety scores and pulse rate. This suggests, preliminarily, that listening to music could be associated with reduced anxiety, as per both physiological and psychological measures.

Results from this pilot were encouraging, suggesting that further research exploring the effect of music listening on subjective anxiety and pulse rate after a stressor would be valuable to explore patterns found, and supporting progression to a proof-of-concept study, as per the “exploratory trial” stage of the adapted MRC guidelines.

Chapter 4 Exploratory trial

This chapter reports an analogue, proof-of-concept study, which constitutes the key experimental study conducted within this thesis. This proof-of-concept study fulfills the main aim of this thesis: to examine the effects of listening to optimal musical stimuli in response to an anxiety induction protocol developed to model an anxiety disorder. This study also comprises the "exploratory trial" phase of the MRC's framework for the development and evaluation of complex interventions (2000; 2008), as adapted for this thesis. Within the context of this thesis, the exploratory trial phase has been conducted as a means of investigating proof of concept for music listening's capacity to reduce anxiety in a situation analogous to an anxiety disorder, within a general population. Because of the lack of research conceptualising and testing music listening in a context analogous to an anxiety disorder, there is currently insufficient evidence to warrant a trial with a clinical population. As such, this study provides an empirical building block towards an RCT testing the effects of music listening with a population with anxiety disorders.

The theoretical rationale and supporting evidence for conducting this proof-of-concept study were introduced and discussed in Chapter 2. The theoretical rationale stems from a synthesis of literature from the fields of clinical psychology and music psychology. Clinical psychology literature discusses the roles of physiological arousal and worry in the treatment of anxiety disorders, and research on the mood-as-input hypothesis suggests that positive affect can reduce dysfunctional perseveration, such as worry. Music psychology literature, specifically that focusing on music and emotions, provides evidence that supports the concept that listening to music can reduce physiological arousal and promote positive affect, and pinpoints musical features that are most likely to promote these reactions: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes. Other music psychology literature has investigated the effects of music listening on anxiety in situations that are not analogous to an anxiety disorder, and has produced evidence supporting the beneficial effects that music listening can have in these situational anxiety contexts.

Chapter 3 reported the development work that was undertaken in preparation for this analogue study. This development work included using the stimulus criteria, as synthesised from music psychology literature, to select optimal stimuli for reducing anxiety, development of an anxiety induction protocol to model a context analogous to an anxiety disorder, and piloting the protocol for the analogue study.

Results from the pilot study showed that the anxiety induction protocol was effective at increasing subjective anxiety and pulse rate, and that both musical stimuli were equally effective at reducing subjective anxiety and pulse rate in response to this anxiety induction protocol. As such, an analogue, proof-of-concept study was conducted with a larger population, and this study is the focus of this chapter of the thesis.

Because of the effectiveness of the anxiety induction protocol in the pilot study, the protocol remained the same in the analogue study. The methods remain almost unchanged, apart the addition of skin resistance as an outcome measure, and different proportions of participants being randomised to the three conditions.

Skin resistance was included as a measure in the analogue study. While high pulse rate is an indicator of increased physiological arousal, skin resistance is the inverse, with heightened levels of skin resistance associated with lower physiological arousal. It had been anticipated that this measure would be included in the previous development work, but, due to malfunctioning equipment, this was not possible.

In the pilot study, participants were randomised equally to one of three conditions. Because no difference was found between music conditions in the pilot study, and to facilitate equal numbers of participants in the music and white noise conditions in the analogue study, participants were randomised equally to either music or white noise, and then those in the music group were randomised equally to either stimulus.

4.1.1 Methods

4.1.1.1 Design

As in the pilot, this study was a single blind, proof-of-concept, randomised control trial, comparing the effects of listening to music (experimental condition) and white noise (control condition) after an anxiety induction protocol. The primary outcome was subjective anxiety, and secondary measures were pulse rate and skin resistance (the inverse of skin conductance).

An equal number of participants were randomised to each condition. Within those in the music condition, participants were randomised to one of two music conditions (see Section 4.1.1.5 for more stimulus details).

As in the pilot study, the allocation was single blinded, meaning that the experimenter knew which conditions participants had been assigned to, but that the participants themselves did not. As the experimenter did not take ratings or observations regarding primary outcomes, the lack of double blinding should not have affected results. Participants were not informed that the listening phase was of particular interest to the experimenter, and were not aware that other participants may have had different listening stimuli. There was no double blinding, because it was necessary for the experimenter to select the appropriate stimulus during the experiment. The experimenter followed a script to maximise consistency and ensure the protocol was followed correctly.

The study protocol was approved by the ethics committee for the School of Health in Social Science at the University of Edinburgh.

4.1.1.2 Participants

As with the pilot study, participants were recruited through an advertisement in the online careers portal at the University of Edinburgh, which framed the experiment as a "mental visualisation study" (see Appendix N). The advertisement specified one inclusion criterion and one exclusion criterion. For inclusion, applicants should be students at the University of Edinburgh. This was because the experiment involved giving a presentation about the subject the participant was currently studying. When informed about the presentation, one participant reported that they were not a current student, but a graduate of the university. They were requested to give the presentation about the subject they had studied when at university. The exclusion criterion was that they should not have previously participated in any studies run by the experimenter. Interested candidates were advised to contact the experimenter via email. On receipt of the email, they were asked to submit their availability on Doodle, an online scheduling system. The researcher then contacted them to confirm a suitable time slot.

A total of 58 individuals participated in the study, equally distributed between experimental and control conditions. Two participants in the white noise condition were excluded from all analyses, one because their mobile phone rang during the experimental phase, and the other because they reported that the white noise made them unable to comply with the experimental protocol.

In the subjective anxiety analyses, all 56 (29 music, 27 control) remaining participants are included. Within these participants, the average age was 22.91 (SD = 5.85, range = 18-53). 20 of the participants were male (35.7%), and 36 were female (64.3%). Due to malfunctioning equipment, one participant (male) was excluded from both pulse rate and skin resistance analyses, and a further six participants (all female) were excluded from skin resistance analyses (2 participants in the music group and 4 in the control group).

4.1.1.3 Measures

4.1.1.3.1 Subjective anxiety

As in the pilot study, subjective anxiety was measured using the short form of the state scale of the State-Trait Anxiety Inventory (STAI-SF). This short form was developed by Marteau and Bekker (1992), adapted from Spielberger's (1983) full STAI. The STAI and its short form have been used in a number of studies examining the effects of music listening on anxiety (such as Chlan, 1998; Nguyen et al., 2010; S. Nilsson et al., 2009a).

The STAI-SF, as developed by Marteau and Bekker (1992), was found to be an acceptable substitution for the full STAI ($r > .90$, $\alpha = .82$). As opposed to the state scale of the full STAI, which has 20 items (Spielberger, 1983), the STAI-SF consists of six items, which are combined to create one overall state anxiety score. As such, the STAI-SF takes substantially less time to administer, which makes it particularly suitable for an intervention testing context.

The items consist of the following statements: 1) “I feel calm”, 2) “I am tense”, 3) “I feel upset”, 4) “I am relaxed”, 5) “I feel content”, and 6) “I am worried”. Participants are asked to rate these on a 4-point scale, for how much the item matches how the participant feels at the time of completing the questionnaire, from 1 (“Not at all”) to 4 (“Very much”). Possible scores range from 6 to 24, with 24 indicating the highest level of anxiety.

Scores for the STAI-SF were calculated by reversing items 1 (calm), 4 (relaxed), and 5 (content), and adding these to the raw ratings from the other items, as recommended by Marteau and Bekker (1992).

As in the pilot study, the STAI-SF was introduced to the participants as a mood questionnaire, rather than an anxiety questionnaire, to minimise response bias.

4.1.1.3.2 Physiological

Physiological measures were included in addition to the self report, subjective anxiety measure (STAI-SF), as a means of allowing investigation into both the physiological and affective responses of the participants. The specific physiological measures used were pulse rate and skin resistance, which are frequently used as markers of physiological arousal in music and anxiety studies. While pulse rate is an indicator of increased physiological arousal, skin resistance (the inverse of skin conductance) is a sign of decreased physiological arousal. Pulse rate and skin resistance data were gathered using a wireless device produced by Mobile Healthcare Networks (MHN Ltd), [18] a medical technology company based in Edinburgh. This wireless device consisted of fingertip sensors on the fingers, attached to a wristband, which gathered the data. Pulse rate and skin resistance data was transmitted live to a netbook using equipment developed by MHN Ltd. Pulse rate and skin resistance were measured continuously from connection of the system at the beginning of the session, to disconnection after debriefing, with mean values calculated for each time point (see Section 4.1.1.6 for details of the procedure). The portable nature of this

[18] http://www.mobilehealthcarenetworks.com/

device, combined with its wireless functionality, made it minimally invasive for participants to wear.

4.1.1.3.2.1 Pulse rate

As in the pilot study, pulse rate, in beats per minute (bpm), was measured using a transmissive infrared fingertip sensor worn on the middle fingertip of the non-dominant hand. The sensor averages pulse rate values over four seconds, with a new average calculated approximately 10 times per second. This device was produced by Nonin Medical,[19] an established manufacturer of medical devices.

4.1.1.3.2.2 Skin resistance

Skin resistance (the inverse of skin conductance), was also measured (in ohms). The skin sensor was developed in house, by MHN Ltd, and consists of two contact pads, also worn on the fingertips. It had been intended for skin resistance to be measured in the stimulus explorations and the anxiety induction pilot, but the equipment was in the development stage and was not functional as soon as had been anticipated. As such, it was only used in the proof-of-concept study. Because there had been no opportunity to pilot this measure, it was included as an extra, exploratory variable.

4.1.1.3.3 Other questionnaires

As in the pilot study, to gather further information about the participants, three questionnaires were administered: A personal information questionnaire and a tasks questionnaire (both given at the end of the experimental session to all participants), and a music questionnaire (for those in the experimental condition, given after the subjective anxiety questionnaire following the musical stimulus).

The personal information questionnaire can be seen in Appendix O. This questionnaire was used to collect and compare demographic information between conditions. This included questions about age, gender, caffeine consumption in the three hours prior to the experimental session, and whether participants had any diagnoses of medical conditions. It also asked if the participant had played any

[19] http://www.nonin.com/index.aspx

musical instruments, and how long they had learned them for. This was changed slightly from the questionnaire used in the pilot study, by improving formatting of the music experience questions and adding an exam question. These questions were included as a means of gathering information in case of unusual physiological or self-report responses from participants.

The tasks questionnaire can be found in Appendix P. This was designed as a manipulation check to assess the believability of, and the mechanisms behind, the anxiety induction protocol. One statement was added to those used in the anxiety induction pilot. As such, ten statements (see Table 4.9 for statements and responses) about the protocol were given, with participants asked to rate how much they agreed with each, from 1 (strongly disagree) to 5 (strongly agree). In particular, question 3 was used to assess for social-evaluative threat, 6 and 7 for the effects of the mental visualisation exercise, and 8 for the believability of the protocol.

In order to obtain information on the participants' opinion of the musical stimuli, a music questionnaire was used. This asked participants: 1) how much they liked the music (from -3, indicating strong dislike, 0, indicating neutrality, to +3, indicating strong liking); 2) how familiar they were with the music (possible responses being a) "I've never heard that music before", b) "I might have heard that music before"; c) "I have heard that music before but couldn't identify it", and d) "I definitely know that music, and could identify it), 3) whether they associated any of the music with a specific event or memory, and if so; 4) whether the event or memory was positive, negative, both, or neither; and 5) whether they had played the music. This was unchanged from the questionnaire used in the anxiety induction pilot, and as such can be found in Appendix G. As with the music experience questions, this questionnaire was included to gather information to explore in the case of unusual responses.

4.1.1.4 Time points

As in the pilot study, physiological responses were measured continuously, but there were three windows of interest for analysis. A subjective anxiety questionnaire was given to the participant immediately following each of these time windows:

1) The initial baseline, occurring 5 minutes after the physiological sensors were connected (habituation period), and lasting 60 seconds. The length of this habituation period and baseline were recommended by the developers of the wireless measurements device as an appropriate length of time to gain accurate results.

2) The anxiety baseline, occurring after the participant was informed that they would be asked to give a presentation, while they were first reading through the mental visualisation exercise, also lasting 60 seconds.

3) The experimental condition, occurring while the participant was completing the mental visualisation exercise, and while they were listening to the experimental stimulus (either music or white noise) through headphones. This lasted for the full length of the stimulus, 3 minutes and 44 seconds.

For pulse rate and skin resistance, a mean of each time period was taken.

4.1.1.5 Stimuli

4.1.1.5.1 Music (experimental condition)

Participants in the experimental condition were assigned to one of two musical stimuli. Based on the literature discussed in the introduction, these stimuli were selected to comply with the following criteria, previously identified as being linked with low arousal and high valence: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

The stimuli were as follows:

1) A combination of two partial tracks entitled ‘Dawn’ and ‘The Secret’ (Dario Marianelli, Decca Records) from the original soundtrack of *Pride and Prejudice* (2005).

2) ‘The Swan’ from *Carnival of the Animals*, by Camille Saint-Saëns (Gérard Leclerc, Sirius).

‘The Swan’ was chosen via a small pilot, where four music psychology researchers rated a selection of stimuli on Likert scales for arousal and valence (as per the dimensional model of emotions). ‘The Swan’ was most consistently rated as high valence and low arousal.

‘Dawn’ and ‘The Secret’ were identified from a listening experiment by Eerola and Vuoskoski (2011) where 116 participants rated 110 short excerpts of film music. Both ‘Dawn’ and ‘The Secret’ were rated as eliciting high valence and low tension.

Using two stimuli that had been chosen by different methods (one from a pilot study by the authors, and the other from the literature), but which contained similar musical features, was a means of evaluating the selection criteria.

4.1.1.5.2 White noise (control condition)

The control stimulus was white noise.[20] White noise was used as an alternative to silence, as it provided a reason to give headphones to the participants in the control condition, keeping the conditions as similar as possible. White noise is an emotionally-neutral, auditory stimulus, and has been used effectively as a control condition in music psychology studies (such as Mitchell & MacDonald, 2006)

All stimuli (experimental and control) were cut to the same length, 3 minutes and 44 seconds, using audio editing software, to maximise consistency between conditions.

4.1.1.6 Procedure

This experiment followed the procedure outlined in Table 4.1. Participants were tested individually.

[20] SimplyNoise's Signature White Noise, downloaded from http://simplynoise.com

Table 4.1: Experimental procedure

Music condition	White noise condition	Time points	Duration
Welcome			
Consent			
Connect to pulse sensor			
Habituation			5m
Sit quietly		Time 1: PR and SR	1m
Complete STAI-SF (1)		Time 1: STAI-SF	
Explain presentation			
Show marking scheme			
Introduce mental visualisation exercise			
Initial read-through of mental visualisation exercise		Time 2: PR and SR	1m
Complete STAI-SF (2)		Time 2: STAI-SF	
Give headphones			
Explain music	Explain white noise		
Play music	Play white noise	Time 3: PR and SR	3m 44s
Complete STAI-SF (3)		Time 3: STAI-SF	
Complete music questionnaire	N/A		
Debrief			
Disconnect from pulse sensor			
Complete tasks questionnaire			
Complete personal information questionnaire			

After baseline measures were taken for STAI-SF and pulse rate (time 1), participants were informed that they would be asked to give a five-minute oral presentation about the subject they studied to two other experimenters and their participants.

Participants were told that they would be given a mental visualisation exercise to complete while they awaited the presentation, and that the experimenters would be marking all of the presentations on a marking scheme (see below for further details of the mental visualisation exercise and the marking scheme).

After being shown the marking scheme, participants were given one minute to read through the mental visualisation exercise (time 2 - pulse rate). At this point, a second anxiety questionnaire was given (time 2 – STAI-SF).

Before they continued with the mental visualisation exercise, participants were given headphones, and told they would be played either music (for the experimental condition) or white noise (for the control condition), to help "block out any background noise" while they completed the exercise. Participants were given just under four minutes to do this, corresponding with the duration of the stimuli (time 3 - pulse rate).

Once the stimuli were over, a third anxiety questionnaire was given (time 3 – STAI-SF), followed by a music questionnaire for those in the experimental condition. Participants were then informed that they would not be required to give a presentation, debriefed fully as to the purposes of the experiment, and asked to complete the personal information and tasks questionnaires.

4.1.1.6.1 Anxiety induction elements

The anxiety induction protocol was designed to be 1) anticipatory, 2) worry-based, and to contain elements of 3) uncontrollability and 4) social-evaluative threat.

4.1.1.6.1.1 Oral presentation

The focus of the experiment was the anticipation of an oral presentation. Participants were informed that their presentation should last for five minutes, and be based on the subject they were studying. To heighten the feeling of uncontrollability and promote worry during this anticipation period, participants were not asked to prepare for the presentation. It was felt that preparation time would promote constructive, rather than worry-based thought.

4.1.1.6.1.2 Mental visualisation protocol

To promote worry-based thought while discouraging preparation for the presentation, participants were asked to complete a mental visualisation exercise while they awaited the presentation (as in pilot study, see Appendix L). The exercise was based on previous questionnaires (J. R. Brown, 2011; Kocovski et al., 2011), but was shortened and reworded to make it suitable for this experiment. In the verbal introduction to the exercise, it was emphasised that participants were not to give written or spoken answers to the exercise, but rather to visualise each question. This was designed to encourage rumination over the past event and promote worry about the upcoming presentation, and to avoid interference with physiological data that might occur from writing or speaking.

4.1.1.6.1.3 Marking scheme

To increase the sense of social-evaluative threat and uncontrollability (Dickerson & Kemeny, 2004), participants were shown the marking scheme that would be used to assess their presentation (see Appendix M). This was created in response to feedback from pilot studies.

4.1.1.6.1.4 Set-up

Participants were led to believe that they would be giving a 5 minute presentation to 5 people (two other participants and three experimenters). As participants had not been informed that the experiment included a presentation until after baseline measures had been taken (at time 1), the following steps were taken to give the impression that other participants were taking part in concurrent sessions: Emails to the participant referred to “experimenters”, with the actual experimenter referred to as the “lead experimenter”; on arrival at the study location, signs directed to a waiting area for multiple experimenters; when the participant was met by the experimenter they were asked which experimenter they were waiting for (although, in reality, all participants were tested by the same experimenter); a presentation area was set up in the room.

4.1.1.7 Hypotheses

4.1.1.7.1 Anxiety induction

It was hypothesised that pulse rate and subjective anxiety (as per the STAI-SF) would increase between time 1 (baseline) and time 2 (anxiety baseline), and that skin resistance would decrease.

4.1.1.7.2 Music effect

It was hypothesised that the participants randomised to the music conditions (music 1 and music 2) would experience a drop in pulse rate and subjective anxiety (as per the STAI-SF) between time 2 and 3, and a rise in skin resistance, while the control condition (white noise) would experience no difference in these scores between these time points.

4.1.1.8 Data analysis

Separate mixed 3 (time) x 2 (condition) ANOVAs were used to explore the effects of the anxiety induction protocol and of the listening stimuli on the primary outcome (subjective anxiety) and the secondary outcomes (pulse rate and skin resistance). Simple contrasts were used to test specific within group hypotheses (conducted separately per group), namely the difference in subjective anxiety, pulse rate, and skin resistance between time 1 and time 2, and between time 2 and 3.

Initial analysis of skin resistance revealed incredibly high standard deviations (of up to 750). As such, normalised skin resistance scores were calculated by dividing the mean for time 2 and time 3 by the mean for time 1, for each participant, as recommended by Basmaijian and De Luca (1985) and as performed by Coutinho and Cangelosi (2011). This normalised score depicts change from baseline (time 1).

To ensure that the distribution met the assumptions for a parametric test such as ANOVA, skew and kurtosis values were reported as recommended by Field (2013). These values, along with their z scores, were calculated for each dependent variable at each time point, separated by condition (music or white noise). These values are reported in Table 4.2. Only one value was significant (with a z score lying outwith 1.96 and -1.96), in that significant kurtosis was found for pulse rate at time 3 in the white noise condition, and as such parametric techniques were used.

Table 4.2: Skew and kurtosis

Measure	Time	Condition	Skew	Kurtosis
Subjective anxiety	1	Music	0.720	-0.375
		White noise	-0.145	-0.550
	2	Music	0.559	-0.079
		White noise	0.522	1.451
	3	Music	0.073	-0.560
		White noise	-0.845	1.464
Pulse rate	1	Music	-0.036	-0.324
		White noise	0.011	0.464
	2	Music	0.018	0.151
		White noise	0.116	1.674
	3	Music	0.139	0.145
		White noise	0.572	2.458*
Skin resistance	1	Music	n/a	n/a
		White noise	n/a	n/a
	2	Music	0.241	-1.033
		White noise	-0.098	-1.137
	3	Music	0.227	-1.011
		White noise	0.239	-1.070

*z = 2.771

Tests for other assumptions, including Levene's test for homogeneity of variance, Box's test for homogeneity of intercorrelations, and Mauchly's test for sphericity, are reported within the results section.

4.1.2 Results

4.1.2.1 Demographic information

Information on age and gender for each condition is reported in Table 4.3.

Chi-square tests were used to examine differences in gender, reported anxiety disorder or depression, and reported consumption of caffeine, and a t test was used to examine differences in age. No significant differences were found between condition for gender (p = .09), caffeine consumption (p = .22), age (p = .81), or diagnoses of anxiety disorders or depression (p = .05).

Table 4.3: Overview of study participants

	Music (n = 29)		White noise (n = 27)	
	M	*SD*	*M*	*SD*
Mean age (years)	22.7	6.28	23.1	5.43
	M	%	*M*	%
Gender: Female	22	75.9	14	51.9
Reported anxiety disorder or depression: Yes	5	17.2	0	0
Consumed caffeine before session: Yes	12	41.4	7	25.9

4.1.2.2 Effect of music listening during anxiety induction protocol

Separate 3 (time) x 2 (condition) ANOVAs were conducted to explore the effect of the anxiety induction protocol and the listening conditions on subjective anxiety (see Table 4.4), pulse rate, and skin resistance. The repeated measures were, respectively, STAI-SF score, mean pulse rate, and skin resistance at times 1, 2, and 3. The between-subjects factor was listening condition (music or white noise).

Table 4.4: STAI-SF scores, pulse rate, and skin resistance at each time point

		Music		White noise	
		M	*SD*	*M*	*SD*
STAI-SF	Time 1	8.79	2.06	9.41	1.78

		Music		White noise	
		M	*SD*	*M*	*SD*
	Time 2	12.97	2.86	13.22	13.59
	Time 3	11.31	3.05	13.59	2.72
Pulse rate (bpm)	Time 1	78.57	13.97	73.38	12.9
	Time 2	82.59	16.16	77.54	14.01
	Time 3	80.17	15.55	77	14.18
Skin resistance (normalised)	Time 1	1	0	1	0
	Time 2	.5586	.19	.5992	.25
	Time 3	.5414	.19	.6074	.22

4.1.2.2.1 Subjective anxiety (STAI-SF).

For subjective anxiety, Box's test suggested that the assumption of equality of covariance matrices was not violated (p = .30). Mauchly's test suggested that the assumption of sphericity was not violated (p =.47). Levene's test suggested that the assumption of equality of variances was not violated at time 1 (p = .65), time 2 (p = .29), or time 3 (p = .23).

For overall subjective anxiety, the ANOVA showed a significant main effect of time F (2, 53) = 70.48, p < .001, partial η^2 = .57. According to Cohen's (1988) guidelines, this was a very large effect. There was also a moderate significant interaction effect between time and condition, F (2, 53) = 4.48, p = .014, partial η^2 = .08, with STAI-SF scores increasing slightly in the control condition and decreasing in the experimental condition between times 2 and 3. No significant main effect of condition was found for subjective anxiety (p = .05). See Figure 4.1 for a graph of this ANOVA.

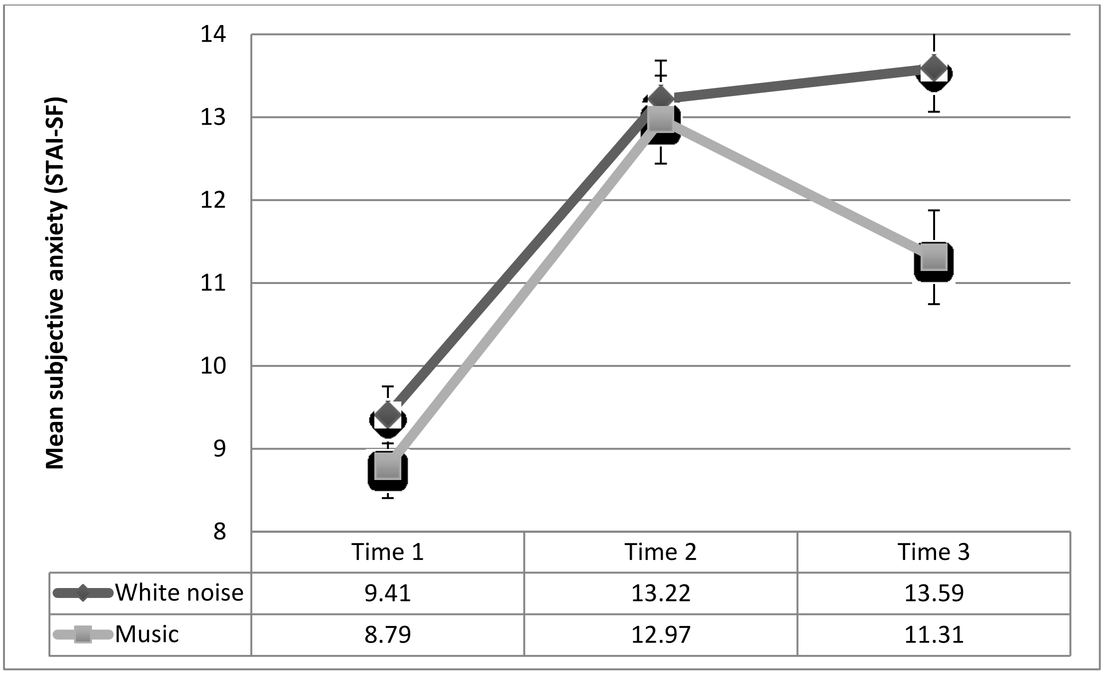


Figure 4.1: STAI-SF scores and standard error by condition and time point

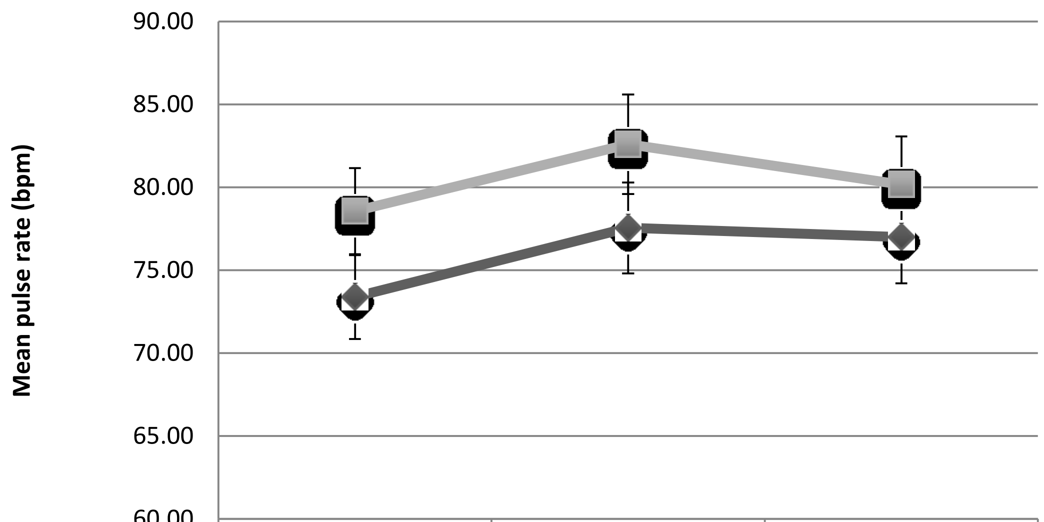
Simple contrasts revealed a large significant difference between time 1 and time 2 in the experimental condition, F (1, 28) = 50.10, $p < .001$, partial $\eta^2 = .64$, and in the control condition, F (1, 26) = 79.78, $p < .001$, partial $\eta^2 = .75$), with STAI-SF scores increasing between times 1 and 2 in both conditions, indicating that the anxiety induction protocol was successful in increasing subjective anxiety. Between times 2 and 3, STAI-SF scores dropped significantly in the experimental condition, F (1, 28) = 9.40, $p = .005$, partial $\eta^2 = .25$, but did not change significantly in the control condition ($p = .32$).

4.1.2.2.2 Pulse rate (bpm)

For pulse rate, Box's test suggested that the assumption of equality of covariance matrices was not violated ($p = .69$). Mauchly's test suggested that the assumption of sphericity was violated ($\chi^2(2) = 16.5$, $p < .001$). Levene's test suggested that the assumption of equality of variances was not violated at time 1 ($p = .53$), time 2 ($p = .36$), or time 3 ($p = .51$).

Because the assumption of sphericity was violated, and the epsilon value for Greehouse-Geisser was greater than .75, the Huynh-Feldt correction was applied (Field, 2013).

For pulse rate, the ANOVA showed a large significant main effect for time, F (1.643, 52) = 16.624, $p < .001$, partial $\eta^2 = .24$, with an increase in mean pulse rate between time 1 and 2 occurring for both conditions. No statistically significant interaction effect ($p = .29$) or main effect for condition ($p = .25$) was found in the pulse rate data. See Figure 4.2 for a graph of this data.



	Time 1	Time 2	Time 3
White noise	73.38	77.55	77.00
Music	78.57	82.59	80.17

Figure 4.2: Pulse rate and standard error by condition and time point

Simple contrasts revealed a large significant difference between time 1 and time 2 in the experimental condition, F (1, 28) = 12.89, $p = .001$, partial $\eta^2 = .32$, and in the control condition, F (1, 25) = 10.79, $p = .003$, partial $\eta^2 = .31$, with mean pulse rate increasing between times 1 and 2 in both conditions, indicating that the anxiety induction protocol was successful in increasing pulse rate. Between times 2 and 3, pulse rate dropped significantly in the experimental condition, F (1, 28) = 9.88, p = .004, partial $\eta^2 = .25$, but did not change significantly in the control condition (p = .4).

4.1.2.2.3 Skin resistance

For skin resistance, Box's test was not appropriate because, due to the normalised scores, there were fewer than two nonsingular cell covariance matrices. Mauchly's test suggested that the assumption of sphericity was violated (χ^2 (2) = 52.0 p < .001). Levene's test suggested that the assumption of equality of variances was not violated at time 2 (p = .39), but it was violated at time 3 (F = 5.10, p = .03).

Because the assumption of sphericity was violated, and the epsilon value for Greehouse-Geisser was less than .75, the Greenhouse-Geisser correction was applied.

ANOVA is considered fairly robust to violation of the assumption of equality of variances where the group size is fairly equal (ratio of no more than 1.5 between largest group size and smallest group size (Stevens, 2009). In this case, the largest group (experimental condition) had 27 participants, and the smallest group (control condition) had 22 participants, making a ratio of 1.23, under the 1.5 threshold.

For skin resistance, the ANOVA showed a large, significant main effect for time, F (1.193, 47) = 156.428, p < .001, partial η^2 = .77, with a decrease in skin resistance scores between time 1 and 2 occurring for both conditions. No statistically significant interaction effect (p = .42) or main effect for condition (p = .41) was found in the skin resistance data. See Figure 4.3 for a graph of this data.

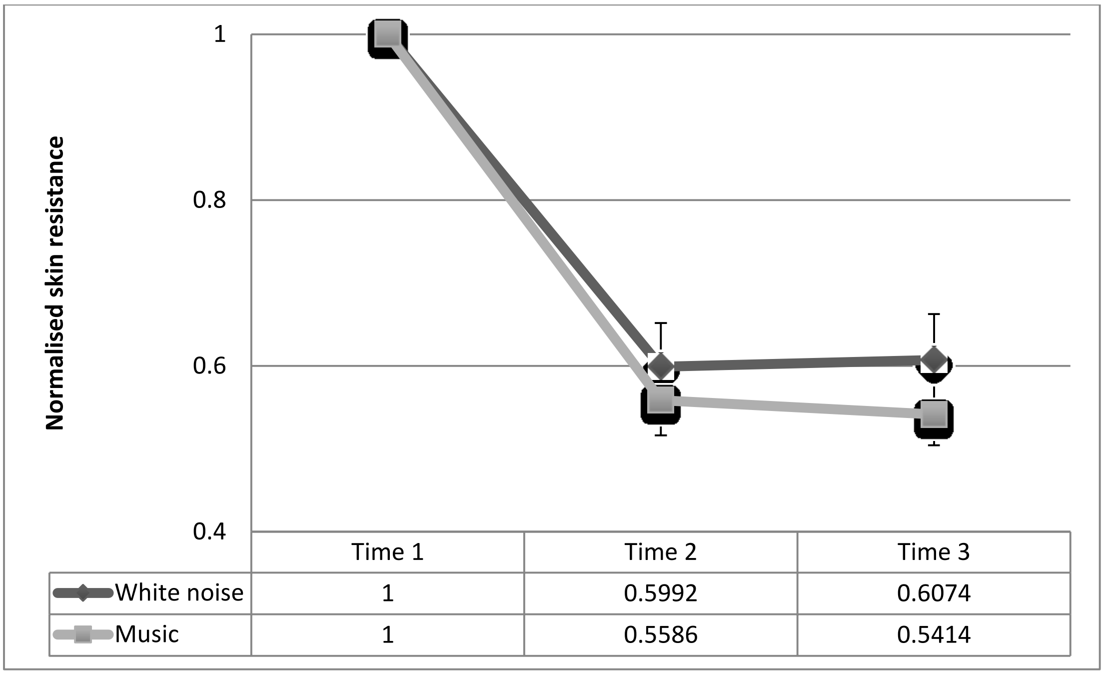


Figure 4.3: Normalised skin resistance and standard error by condition and time point

Simple contrasts revealed a large, significant difference between time 1 and time 2 in the experimental condition, F (1, 26) = 107.99, p < .001, partial η^2 = .81, and in the control condition, F (1, 21) = 58.19, p < .001, partial η^2 = .74), with skin resistance decreasing between times 1 and 2 in both conditions, indicating that the anxiety induction protocol was successful in reducing skin resistance. Between times 2 and 3, skin resistance did not change significantly in either the experimental (p = .3) or control condition (p = .63).

4.1.2.2.4 Correlation between dependent variables

Scatterplots were generated to explore the relationship between each variable at each time point, separated by condition. A linear relationship was not observed in any of the scatterplots, and as such Spearman’s rank correlation coefficient was used to calculate the correlations between subjective anxiety scores, pulse rate, and skin resistance. Bivariate correlations were conducted for each time point, by listening condition (see Table 4.5, Table 4.6, and Table 4.7).

It was hypothesised that subjective anxiety and pulse rate would be positively correlated, and that skin resistance would correlate negatively with both subjective anxiety and pulse rate, for both conditions, at each time point, and as such one-tailed tests were run.

Between subjective anxiety and pulse rate, there was a moderate correlation at time 3 in the white noise group (r_s = .45, p = .011). Between subjective anxiety and skin resistance, no significant correlations were found. Between pulse rate and skin resistance, there was a moderate correlation at time 3 in the white noise group (r_s = .45, p = .028).

Table 4.5: Correlations between subjective anxiety and pulse rate

	Music	White noise
	r_s	r_s
Time 1	-.025	.222
Time 2	-.036	.295
Time 3	.109	.447*

*p = .011

Table 4.6: Correlations between subjective anxiety and skin resistance

	Music	White noise
	r_s	r_s
Time 1	n/a	n/a
Time 2	.142	-.342
Time 3	.087	-.194

Table 4.7: Correlations between pulse rate and skin resistance

	Music	White noise
	r_s	r_s
Time 1	n/a	n/a
Time 2	.038	-.338
Time 3	.007	.-.414*

*p = .028

4.1.2.2.5 Music condition

As an additional exploratory analysis, separate 3 x 2 ANOVAs were also conducted to compare the two music conditions.

Box's test suggested that the assumption of equality of covariance matrices was not violated for subjective anxiety (p = .83) or pulse rate (p = .27). Mauchly's test suggested that the assumption of sphericity was not violated for subjective anxiety (p = .87) or pulse rate (p = .10), but it was violated for skin resistance (χ^2 (2) = 25.12, p < .001). Levene's test suggested that the assumption of equality of variances was not violated for subjective anxiety (time 1: p = .39, time 2: p = .41; time 3: p = .74), pulse rate (time 1: p = .63, time 2: p = .56; time 3: p = .24) or skin resistance (time 1: p = , time 2: p = ; time 3: p =).

As the epsilon value for Greenhouse-Geisser was less than .75, the Greenhouse-Geisser correction was applied for skin resistance data.

No significant main effects for condition were found for subjective anxiety (p = .55), pulse rate (p = .32), or skin resistance (p = .75). No significant interaction effect between time and condition was found for subjective anxiety (p = .91) or pulse rate (p = .67), or skin resistance (p = .77).

4.1.2.3 Music questionnaire

Responses from the music questionnaire (given only to those in the experimental condition) can be seen in Table 4.8. Results are presented separately for each musical stimulus. Fewer participants were completely unfamiliar with 'The Swan' than with 'Dawn/The Secret', and more positive associations were reported for 'The Swan'. As no significant differences were found between the two music conditions for any of the dependent variables, no further analyses were run using the questionnaire results.

Table 4.8: Music questionnaire results

	Dawn/The Secret		The Swan	
	n	%	n	%
Number of participants	15		14	

Liking: +1 to +3	13	86.7	13	92.9
Familiarity: "I've never heard that music before"	5	33.3	4	28.6
Positive association	1	6.7	4	28.6
Negative association	1	6.7	0	0
Played music	0	0	2	14.3

4.1.2.4 Tasks questionnaire

Results from the tasks questionnaire (given to all participants), presented by condition, can be seen in Table 4.9. Number (and percentage) of participants who answered "agree" or "strongly agree" are reported. There was no significant difference between conditions in these results, apart from question 10, "I was nervous about the presentation", χ^2 (4, N = 56) = 11.47, p = .02, with fewer participants in the experimental condition reporting that they agreed with the statement.

Table 4.9: Tasks questionnaire results (n and percentage who agreed with statement)

	Music		White noise	
	n	%	n	%
1. I was excited about the presentation	11	37.9%	8	29.6
2. I hate giving presentations	12	41.3	13	48
3. I was worried about people judging me negatively in the presentation	21	72.4	21	77.7
4. I thought I would give a bad presentation	9	31	1	40.7
5. I enjoy giving presentations	12	41.3	9	33.3
6. Thinking about the previous presentation made me feel ready to present	11	37.9	10	37
7. Thinking about the previous presentation made me feel more nervous about presenting	11	37.9	13	48.1
8. I didn't believe I'd have to give a presentation	4	13.8	4	14.8
9. I thought I would give a great presentation	13	44.8	6	22.2

10. I was nervous about the presentation	19	65.5	22	92.6

4.1.3 Summary

This analogue, proof-of-concept study is the first to examine music listening during an anticipatory, worry-based anxiety induction protocol. It was predicted 1) that subjective anxiety and physiological arousal would initially increase in response to the anxiety induction protocol, and 2) that subjective anxiety and physiological arousal would then decrease for those who listened to music, but would stay the same for those who listened to white noise.

Subjective anxiety results matched the first two predictions. Firstly, scores rose significantly in response to the anxiety induction protocol. This is consistent with previous studies showing the effectiveness of public speaking interventions at inducing anxiety (Pelletier, 2004) and that increases in anxiety can be prompted without presentations actually being delivered (Knight & Rickard, 2001). In addition, these results confirm the effectiveness of the newly-designed, worry-based protocol used in this study, which we believe to be closer to the anxiety experienced by those with anxiety disorders.

Secondly, subjective anxiety scores decreased significantly for the experimental (music) condition while staying static in the control (white noise) condition. These findings are consistent with those reported by Knight and Rickard (2001), which examined music listening in response to an anticipatory stressor, but conflict with those described by Thoma and colleagues (2013). This suggests that the anxiety induction protocol could be an effective way for future studies to investigate music listening in response to worry-based anxiety, and that music listening might be an effective strategy for reducing clinical, worry-based anxiety.

Although pulse rate results followed the same trend as the subjective anxiety scores, they were much more varied. The significant main effect for time, and significant difference between time 1 and 2 in both conditions, demonstrates a clear physiological response to the anxiety induction protocol. In our main analysis no significant interaction was found between time and condition for pulse rate. However, contrasts revealed that pulse rate dropped significantly in response to music played after the initial anxiety induction, but stayed the same for those who heard white noise.

Skin resistance results also revealed a main effect for time, with contrasts revealing a decrease in scores between time 1 and 2 in both conditions, reinforcing the effectiveness of the anxiety induction protocol. However, contrasts revealed no significant differences between time 2 and 3 for either the music or the white noise condition.

This variability in physiological measurement is not unprecedented. While some studies have suggested that music is capable of inducing emotional physiological reactions (Khalfa, Bella, Roy, Peretz, & Lupien, 2003; Lundqvist, Carlsson, Hilmersson, & Juslin, 2008; Rickard, 2004), many have found that emotional reactions to music listening yield unexpected physiological responses (Iwanaga et al., 2005; Khalfa, Isabelle, Jean-Pierre, & Manon, 2002). The pulse rate results had a large variability across all participants in both groups, which may account for significant changes in pulse rate only being detected by some analyses. However, including the physiological measures provided valuable information on the effectiveness of the anxiety induction protocol. In addition, contrasts did reflect a difference between the music and white noise conditions in pulse rate results, suggesting that some effect of physiological arousal was present.

Only two significant correlations were found: between pulse rate and subjective anxiety, and between skin resistance and pulse rate at time 3 in the control condition. As the control condition had less varied results throughout, it is unsurprising that the only significant correlation was present in this condition. In addition, it is possible that time is needed for subjective and physiological measures of anxiety to match (Lundqvist et al., 2008), and this was only possible without the intervention of music.

A set of criteria were defined for selecting musical stimuli to be used to decrease anxiety, that is, low arousal and positive valence, and the effects of two musical stimuli which met these criteria were compared experimentally. Decreased anxiety was seen for both musical stimuli, with no significant main effect for musical stimulus or interaction effects between music stimulus and time found, suggesting both stimuli were equally effective. These criteria were thus also found to be effective, and should be used and tested further in future research. These criteria were specifically selected to represent music which can induce increased positive valence and decreased physiological arousal. The results provide increased support for the general argument that listening to music can evoke emotional changes, and the specific argument that listening to music with certain features can reduce anxiety.

The music questionnaire showed that both stimuli were liked by most participants who heard them. Participants were more familiar with ‘The Swan’ than with ‘Dawn/The Secret’, and more emotional associations were reported for ‘The Swan’ (four positive associations, compared to one positive and one negative association for ‘Dawn/The Secret’). Two participants had played ‘The Swan’. Due to the small sample size and the lack of difference found between the music conditions in the ANOVAs, further statistical tests were not conducted to examine the effects of these associations. For future studies, it would be interesting to explore the effect of familiarity with a larger sample. In studies explicitly concerned with isolating mechanisms of musical emotion induction, it may be prudent to select less well-known stimuli.

The tasks questionnaire showed that only eight participants doubted that they would have to give a presentation (four in each condition). Most were nervous about people judging them negatively, indicating an element of social-evaluative threat.

Less than half of the participants reported that the mental visualisation exercise made them feel more nervous about presenting. It is possible that participants were already sufficiently nervous, that they were unaware of the contribution of the exercise to their nerves, or that the exercise was not a necessary part of the protocol. Further research should explore the effects of the anxiety induction protocol with and without the mental visualisation exercise.

Two limitations of note were present within this study. Firstly, as university students were recruited for this study, caution should be used when expanding these results to a more varied population, as it has been argued that university students are not representative of a general population. Similarly, although the two music stimuli used complied with a pre-defined set of criteria, we do not have sufficient data to conclude that all stimuli complying with these criteria will be equally effective. Careful selection of stimuli, and examination in relation to these criteria, is highly recommended in future research.

Secondly, although this difference was not significant, reported diagnoses of anxiety or depression were found only in the music condition. As this only involved five participants, it is not appropriate to conduct further analyses to explore the relationship between these diagnoses and reaction to the anxiety induction protocol or the listening conditions. There was no evidence that this functioned as a confounding variable in this study, but future studies could explore this further.

To summarise, this study has demonstrated the effectiveness of music listening at reducing subjective anxiety in response to a worry-based anxiety induction procedure designed to model anxiety disorders. In addition, this study has introduced and demonstrated the effectiveness of a worry-based anxiety induction protocol. These preliminary results suggest that music listening could have potential benefits for those with anxiety disorders. Future research could explore the use of music listening in specific elements of treatment, such as relaxation training, cognitive restructuring, and as a non worry-based coping strategy. As such, further research is recommended to explore psychological and physiological measures with this population. This proof-of-concept, analogue trial, has provided a stepping stone towards a definitive RCT, paving the way towards the development of an evidence music listening as an intervention for anxiety disorders.

Chapter 5 Discussion and conclusions

This overarching aim of this thesis was to begin investigating the potential benefits of music listening in the treatment of anxiety disorders. This thesis specifically focused on the development and implementation of an analogue study to evaluate the effects of music listening on subjective anxiety and physiological arousal in response to a protocol designed to model an anxiety disorder. This analogue study was designed as a means of establishing the basis for a definitive RCT with a clinical population, thus paving the the way for the application of music listening into treatment for people with anxiety disorders.

The specific aims of this thesis were 1) the identification of stimuli conducive to reducing anxiety within the context of an anxiety disorder, 2) the development of an anxiety induction protocol, or stressor, to model an anxiety disorder, and 3) the examination of the effects of listening to the chosen stimuli in response to the developed anxiety induction protocol.

These aims were achieved using a series of development studies leading up to an analogue, proof-of-concept randomised control trial (RCT). The first aim was addressed using a Facebook poll, a small rating exercise, two stimulus explorations, and a pilot study, reported in Chapter 3. The second aim was also addressed by the pilot study. The third aim was achieved using an analogue, proof-of-concept study, reported in Chapter 4.

The main empirical findings are reported and discussed within Chapter 3 and Chapter 4. This chapter will begin by considering these findings with reference to the three aims of the thesis, in Section 5.1. This will be followed by a discussion of these findings in relation to the relevant literature, in Section 5.2. In Section 5.3, strengths and limitations will be identified. Finally, future research avenues will be suggested in Section 5.4, and implications discussed in Section 5.5.

5.1 Summary of results

5.1.1 Identification of stimuli

In the literature review (Chapter 2), music and emotion studies were reviewed for features that had been associated with promoting positive valence and lowering arousal, and these were synthesised to create stimulus inclusion criteria: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

One stimulus (‘The Swan’ from *Carnival of the Animals*, by Camille Saint-Saëns) was chosen from a small rating exercise, where four participants rated a selection of stimuli (which met the inclusion criteria) for felt arousal and valence. This was then compared with a stimulus identified as inducing positive valence and low arousal in the literature, which also complied with the stimulus inclusion criteria (*Nocturne* (Op. 9 No. 2), by Frédéric Chopin). In the stimulus explorations that followed, both stimuli were associated with ratings of positive valence and low arousal, increased ‘calm’ ratings, and decreased ‘worried’ ratings. This provided very preliminary evidence to suggest that the stimulus inclusion criteria were an effective means of selecting stimuli for reducing anxiety.

The first stimulus was then compared with another stimulus from the literature. This time, the comparison stimulus was made by combining parts of two stimuli (‘Dawn’ and ‘The Secret’ from the original soundtrack of *Pride and Prejudice* (2005)) from a study by Eerola and Vuoskoski (2011), which had been rated as representing perceived low arousal and positive valence in a large (n = 110) study (for more information, see Section 2.2.2). These stimuli (‘Dawn/The Secret’ and ‘The Swan’ were compared in the pilot study and in the analogue study, and no significant differences were found between the stimuli for any of the measures. This provides further preliminary evidence to suggest that the stimulus inclusion criteria were an effective means of identifying stimuli associated with positive valence and low arousal.

5.1.2 Development of anxiety induction protocol

One key component of the experimental work conducted within this thesis was the development and evaluation of an anxiety induction protocol which modelled an anxiety disorder. Development of this protocol was a means of testing music listening in a situation analogous to an anxiety disorder, to investigate the effects of music listening and verify the appropriateness of the stimuli.

This anxiety induction protocol was developed in the pilot study and evaluated in the analogue study. The pilot study was conducted as a parallel randomised control trial, measuring subjective anxiety and pulse rate, with participants randomised to one of three groups: one of two music stimuli or white noise. The anxiety induction protocol was tweaked throughout the experiment in response to verbal and written participant feedback. In the final protocol, participants arrived, were connected to pulse rate sensors, and introduced to the subjective anxiety questionnaire (framed as a mood questionnaire). They were then told that they would be asked to give a five-minute presentation in front of other participants and experimenters about the subject they were studying. Participants were told that the presentation would be assessed by the experimenters on a marking scheme, which they were shown. They were then told that, in the time preceding the presentation, they were to complete a mental visualisation exercise, which was then introduced. The mental visualisation exercise was designed to promote perseverative thought, and asked participants to think about (but not write or talk about) a previous presentation they had given where they had felt nervous, anxious, or stressed. Questions within the exercise directed the participants to consider various aspects of this experience. They were given one minute to read through the exercise, and then were given headphones with either music or white noise “to block out any background noise” for the remainder of the exercise (just under four minutes). After this time had elapsed, the headphones were removed, and participants were debriefed about the purpose of the experiment. They were not asked to give a presentation.

Subjective anxiety measurements were taken at time 1 (baseline), after the participant had arrived and been connected to the pulse sensors; time 2, after the participants had been introduced to the public speaking task and been given one minute to read through the mental visualisation exercise, and at time 3, after headphones were removed. Pulse rate was measured continuously, but there were three windows of interest, all immediately preceding the time points for subjective anxiety. The window for time 1 comprised one minute of sitting quietly, the window for time 2 comprised the initial read-through of the mental visualisation exercise, and the window for time 3 comprised the period where the participants listened to music or white noise.

As reported in Chapter 3, a number of changes were made to arrive at this final protocol. To increase believability, 'Cyberball' (K. Williams, 2010) was removed, and several actions were taken to make it seem like multiple participants were being tested at the same time, including changing room signs and adding a 'presentation area' in the room. To increase the perceived importance of the public speaking task, it was changed from a mock job interview to a five minute presentation, and a marking scheme was included.

After being developed in the pilot study, the anxiety induction protocol was evaluated in the analogue study, with skin resistance added as an additional exploratory measure. It was hypothesised that subjective anxiety and pulse rate would increase in response to the protocol, and that skin resistance would decrease. In the analogue study, the anxiety induction protocol was associated with greatly and significantly increased subjective anxiety and physiological arousal (as measured by pulse rate and skin resistance), suggesting that it successfully resulted in increased anxiety and physiological arousal, and supporting the hypothesis.

In addition, questionnaire responses from the analogue study indicated that the protocol was found to be highly believable, and that participants were worried about people judging them negatively, indicating the presence of social-evaluative threat.

The protocol required only one researcher and one quiet room, in addition to equipment for playing the stimuli and recording the chosen measures, making it a highly resource-efficient protocol for those wishing to induce both the increased physiological arousal and negative perseverative thought associated with an anxiety disorder.

5.1.3 The effects of music listening

The main goal of this thesis was to evaluate the effects of listening to optimal music (selected to address aim 1) in a situation analogous to an anxiety disorder (developed to address aim 2). Having selected optimal stimuli and developed an anxiety induction protocol in a series of preliminary development studies, the effects of music listening on subjective anxiety, pulse rate, and skin resistance were evaluated in an analogue, proof-of-concept, RCT (to fulfil aim 3).

In the pilot, participants were randomised equally to the three stimuli. In the analogue study, participants were randomised equally to music or white noise conditions and then further to two music stimuli, meaning that 50% were randomised to white noise, and 25% to each musical condition.

In the analogue study, it was hypothesised that, after listening to the stimulus, subjective anxiety and pulse rate would reduce, and skin resistance would increase, for those in the music listening condition, and stay the same for those in the white noise condition. Results from the analogue study suggested that music was significantly more effective at reducing subjective anxiety in response to the anxiety induction protocol than white noise. Pulse rate results showed a similar trend, but skin resistance results did not. As such, the hypotheses were met, apart from for skin resistance, which was expected to increase, but did not.

5.2 Discussion

This section explores the findings from this thesis in relation to relevant literature in the fields of clinical psychology and music psychology. In particular, this section will refer back to the literature used to develop the conceptualisation of the role for music listening and the anxiety induction protocol, and to the studies which have tested music listening on anxiety in a variety of contexts.

5.2.1 The conceptualised role of music

In the literature review, a role for music listening in the treatment of anxiety disorders was identified. It was argued that listening to music could manipulate both physiological arousal and negative affect (and, via the latter, worry), and that this could prove valuable in the treatment of anxiety disorders. In particular, literature that targeted the mechanisms of physiological arousal and worry as important points to address in treatment was drawn upon.

This was linked with evidence from the field of music psychology that had found associations between these mechanisms and certain musical features (Coutinho & Cangelosi, 2011; Gomez & Danuser, 2007; Husain et al., 2002), thus creating a set of stimulus inclusion criteria for selecting optimal stimuli for the purposes of manipulating these mechanisms. Literature exploring the mechanisms behind musical emotion induction, which is still a relatively unexplored area, was also considered. A particular focus was given to two mechanisms from the BRECVEMA framework: Brain stem reflexes and emotional contagion, as they are most relevant to the instant induction of music related to musical features (Juslin et al., 2010; Juslin & Västfjäll, 2008).

In this way, I proposed that, via the mechanisms of emotional contagion and brain stem reflexes, specified musical features can manipulate arousal and valence, and that this could counter physiological arousal and worry (the latter through evoking positive affect, as posed by the mood-as-input hypothesis), and thus be beneficial for treating anxiety disorders. It should be noted that components of this conceptualisation were not directly tested, rather used as a lens through which to view the potential of music listening in the treatment of anxiety disorders. Similarly, the stimulus inclusion criteria were used as a means of selecting optimal stimuli, but were not themselves tested or manipulated.

However, it is possible to revisit the conceptualisation with the enriched perspective gained from the experimental work in this thesis. This will be discussed in reference to literature from both clinical psychology and music psychology.

5.2.1.1 Clinical psychology

In the literature review, a distinction between fear and anxiety was introduced. These terms are often conflated in the literature, but when a difference is made it is temporal in nature, with fear defined as a response to immediate threat (real or perceived) and anxiety as an anticipation of potential future threat. DSM-5, while acknowledging an overlap between the two, lists separate symptoms of fear and anxiety, with fear associated with general surges in physiological arousal and escape behaviours, and anxiety associated with muscle tension (a specific element of physiological arousal) and avoidance behaviours. This seems to suggest that anxiety is associated with increases in muscle tension, rather than other elements of physiological arousal, such as pulse rate. Results from the proof-of-concept, analogue study in this thesis suggested that increases in physiological arousal (measured via pulse rate and skin resistance) were experienced in response to the anxiety induction protocol. This anxiety induction protocol was designed to be anticipatory, with anxiety promoted through the expectation of having to give a presentation.

There are two possible explanations for this. Firstly, it is possible that participants were merely experiencing fear about the immediate situation rather than anxiety about the upcoming presentation. However, this seems unlikely. Had they merely been feeling fearful about the process of participating in an experiment, this surely would have been reflected in baseline measures, and a significant increase in these would not have been observed between baseline (time 1) and the mental visualisation baseline (time 2). Indeed, the tasks completed by the participant seem to hold most potential threat when considered in relation to the upcoming presentation. Secondly, perhaps the overlap between fear and anxiety extends to symptoms of physiological arousal, other than muscle tension, and anxiety can indeed be characterised by similar surges in arousal as those related to fear.

This could also provide an insight into worry's relationship with physiological arousal. As discussed in the literature review, there has been some debate regarding this relationship. Borkovec and colleagues (2004a) argued that worry was associated with muted physiological arousal. Newman and colleagues (2013) have contested this point, arguing that worry actually creates and maintains both negative affective and physiological experiences. Although worry was not measured in the experimental work in this thesis, my findings do suggest that increased physiological arousal was observed in a situation designed to promote worry.

In the literature review, the attentional bias to threat and dysfunctional emotion regulation experienced by those with anxiety disorders were discussed. Although neither of these were explicitly tested in this thesis, it could be argued that both were promoted in the anxiety induction protocol.

Attentional bias to threat was promoted via elements of the protocol that contributed to participants' belief that they would have to give a presentation in front of other people and that this would be assessed. Indeed, questionnaire results suggested that participants did experience social-evaluative threat in response to the anxiety induction protocol.

One possible interpretation of the difference in subjective anxiety and pulse rate observed between the experimental and control conditions is that different emotion regulation strategies were being promoted in these conditions. All participants were initially encouraged to engage in negative, perseverative thought via the mental visualisation exercise. However, once the experimental phase started, it could be argued that participants in the experimental condition were discouraged from using this strategy, thus encouraged to use other strategies such as accepting or reappraising the situation.

A possible narrative can be made here regarding the mood-as-input perseverative thought in relation to the findings from the proof-of-concept, analogue study. Meeten and Davey (2012) found that negative mood paired with an 'as many as can' (AMA) stop rule was associated with increased perseveration of thought. Parallels can be made between this phenomenon and the protocol used in the proof-of-conceput study: The anxiety induction protocol aimed to induce a type of negative affect, anxiety. The protocol also, to an extent, promoted an AMA stop rule, by asking participants to persevere with the mental visualisation exercise for a set amount of time (rather than telling them to stop when they felt like it, as would be as associated with a 'feels like continuing' stop rule). Then, music, a stimulus designed to promote positive affect was given to the participants in the experimental group. Because the exercise was done mentally, no measurements were taken of participants' perseveration, but one interpretation of the findings could be that music listening, by promoting positive affect, decreased subjective anxiety and pulse rate via reduction of perseverative thought.

5.2.1.2 Music psychology

The section of the literature review exploring the field of music and emotion began with an introduction to the emotivist vs cognitive debate: whether music can evoke emotional responses in the listener (the emotivist perspective) or whether it is merely possible to identify emotion expressed by the music (the cognitivist perspective). A large body of research has shown that music can evoke different emotional reactions in the listening, supporting the emotivist perspective. My proof-of-concept study provides further support for the emotivist perspective, with music listening associated with changes in subjective anxiety and pulse rate.

Potential mechanisms behind music listening's capacity to evoke emotional responses were discussed in the literature. These mechanisms were not tested in this thesis, but were used to develop a theoretical rationale for music listening as an intervention for people with anxiety disorders. In particular, brain stem reflexes and emotional contagion were proposed as the most relevant mechanisms to this thesis, because of their high induction speed and focus on more generalisable responses to music (rather than those which are heavily based on personal experiences and preferences).

Egermann and McAdams (2013) examined the link between emotions expressed by the music and those induced in the listener, proposing emotional contagion as a link. Although this was not tested directly, some indirect support for this hypothesis comes from the proof-of-concept study. One of the two stimuli used, 'Dawn/The Secret', had been rated for expressed emotion in a study by Eerola and Vuoskoski (2011), and was rated as expressing low arousal and positive valence (a state considered opposite to anxiety, which would be associated with high arousal and negative valence). In the proof-of-concept study reported in this thesis, induced emotion was measured via subjective anxiety and physiological markers. Both musical stimuli were associated with decreased subjective anxiety and pulse rate, suggesting a reduction in anxiety. This induced emotional response is similar to the expressed emotion rated in Eerola and Vuoskoski's study, suggesting a link between expressed and induced emotions. Emotional contagion remains a possible mechanism behind this link.

Although personal mechanisms of musical emotion induction were not specifically targeted in this experimental work, this does not mean that they did not play a role. Most participants reported liking the musical stimulus they were randomised to, and only one participant reported a negative association with them. As such, negative emotional responses were unlikely to have been evoked by more personal mechanisms such as episodic memory, evaluative conditioning, or aesthetic judgement. However, it is possible that these mechanisms could facilitate negative emotional responses in future participants listening to these stimuli. The effectiveness of the stimuli can be partly attributed to the lack of confounding, negative experiences with the stimuli, such as dislike or negative associations, which could have precluded reductions in anxiety.

Stimuli that met the inclusion criteria were associated with positive valence and low arousal ratings, providing preliminary support for the idea that the criteria were an effective means of choosing stimuli. However, the stimulus inclusion criteria were not tested directly in this thesis and the process for choosing these stimuli was exploratory, and as such findings should be interpreted cautiously. The stimuli used in the pilot and analogue, proof-of-concept studies were associated with decreased subjective anxiety and decreased pulse rate in response to the anxiety induction protocol. As this protocol was designed to increase the mechanisms of negative affect and physiological arousal (and indeed did so, in the form of pulse rate and skin resistance for physiological arousal, and subjective anxiety for affect), the fact that listening to the stimuli decreased these measures suggests that these mechanisms were manipulated, providing support for the conceptualisation. The lack of significant changes in skin resistance data, while not supporting the conceptualisation, does not provide opposing results.

5.2.2 Anxiety induction

This thesis adds to the anxiety induction literature by introducing a highly resource-efficient anxiety induction protocol that models an anxiety disorder.

In the literature review, artificial anxiety induction was introduced. The anxiety induction protocol developed in this thesis was specifically designed to include both the physiological arousal and worry associated with an anxiety disorder.

The protocol developed and evaluated in this thesis was adapted from the Trier Social Stress Test (Kirschbaum et al., 1993), an established, highly effective, anxiety induction protocol. In the Trier Social Stress Test, participants are required to prepare a presentation for a mock job interview, give the presentation in front of an intimidating panel, and then answer questions. They are also told that both audio and video recordings would be taken, and that those will be analysed in relation to the performance.

Research has suggested that this resource-intensive an anxiety induction protocol is not necessary to induce anxiety. For example, in their adaptation of the TSST, Knight and Rickard (2001) found that subjective anxiety, systolic blood pressure, and heart rate increased significantly in response to the anticipation of a public speaking task, and as such that it was not necessary for participants to actually undertake a public speaking task.

In its original form, the TSST was not suitable for the experimental work in this thesis because it is too resource intensive, requiring audiovisual equipment and multiple rooms and research staff to implement, and because it does not focus on the promotion of negative perseverative thought because participants were given time to prepare for the interview.

As such, the protocol developed and evaluated in this thesis was adapted to make it more resource efficient, and to better model an anxiety disorder. To address the first issue, participants were tested individually, and steps were taken to persuade them that other participants were being tested concurrently, to make the imminent presentation more believable. To address the second issue, a mental visualisation exercise was included, adapted from rumination questionnaires (J. R. Brown, 2011; Kocovski et al., 2011), designed to promote negative perseverative thought.

The results from the analogue study supported those found by Knight and Rickard, suggesting that it is possible to induce both increased subjective anxiety and physiological arousal with minimal resources. Of special interest is the fact that the mere anticipation of giving a presentation can induce anxiety, providing a particularly ethically-acceptable, efficient protocol. This allows for participants to be tested individually, with only one researcher needed to run the experiment, meaning that the protocol can be implemented with limited resources.

The findings from the analogue study also support the conceptualisation that effective anxiety induction protocols will contain an element of social-evaluative threat and uncontrollability (as per Dickerson & Kemeny, 2004), and anticipation. In particular, the presence of social-evaluative threat was confirmed by questionnaire results, while anticipation and uncontrollability were built into the protocol but not tested explicitly.

Although the anxiety induction protocol developed in this thesis was designed as a situation analogous to an anxiety disorder, this does not guarantee a simulation of all possible symptoms experienced by those with anxiety disorders, or the mechanisms underlying them. The anxiety induction protocol targeted specific elements of anxiety disorders, namely increased physiological arousal and negative perseverative thought, and to be anticipatory, have a sense of uncontrollability and of social-evaluative threat. It could be argued that attentional bias to threat and dysfunctional emotion regulation were also simulated. However, there is little evidence to suggest to what extent these attempts were successful. Increased pulse rate and decreased skin resistance indicates increased physiological arousal, and questionnaire results supported the presence of social-evaluative threat. In particular, no measure was included examining to what extent participants experienced dysfunctional perseverative thought, such as worry.

5.2.3 The effects of music

The findings from the analogue study extend the music psychology literature and the clinical psychology literature on anxiety by providing preliminary evidence for the effectiveness of music listening at reducing anxiety in a situation analogous to an anxiety disorder. This contributes to the fields of music psychology, by proposing an application for existing research into music and emotion, and to clinical psychology, by suggesting a potential intervention for people with anxiety disorders.

In the literature review, I introduced and discussed the evidence surrounding music listening's effects on subjective anxiety and physiological arousal. Although pooled results are not always consistent, the current evidence base strongly suggests that music listening can be effective on both of those things.

However, the closest studies to the analogue study in this thesis, that is those conducted by Knight and Rickard (2001) and by Thoma and colleagues (2013), had conflicting results.

Knight and Rickard found that listening to music effectively reduced anxiety following an anxiety induction protocol, concluding that this strongly supported the idea that music listening can reduce anxiety in these situations.

Conversely, Thoma and colleagues found that listening to music showed no significant effects. The authors proposed that this lack of effect was due to the overly stressful nature of the task, meaning that music could not be effective in response to such a strong stressor. However, with their results showing that state anxiety decreased for all participants in the experimental phase, it seems that the anxiety abated for all participants, and perhaps that music was not needed.

My findings were generally consistent with those found by Knight and Rickard, contrasting with those found by Thoma and colleagues. A possible explanation for this is that music listening is particularly effective for those who find it hard to recover from stress, such as those with anxiety disorders. This pattern was observed in the Cochrane review focusing on coronary heart patients (Bradt & Dileo, 2009), where music was found to be particularly effective for myocardial infarction (MI) patients, as opposed to surgical/procedural patients, where anxiety attenuated on its own.

The fact that skin resistance results did not match pulse rate results or subjective anxiety is not unprecedented in the literature. Indeed, physiological markers can be notoriously problematic in music psychology studies (Iwanaga et al., 2005). However, the skin resistance results were still useful in that they supported the hypothesis that the anxiety induction protocol would successfully increase physiological arousal.

5.3 Strengths and limitations

A key strength of this thesis is its interdisciplinary nature. Much previous research on music and anxiety seems to have been conducted by health professionals, who may have had varying levels of musical expertise. This thesis combined expertise from both music psychology and clinical psychology, resulting in experimental work that selected stimuli with a clear and specific rationale while drawing from clinical psychology theories and experimental knowledge.

Another strength was the careful, phased approach to collecting data. Taking time to choose appropriate stimuli, develop an anxiety induction protocol analogous to an anxiety disorder, and test stimuli in response to this protocol, were important steps towards testing music listening with a sample with anxiety disorders. Taking such a careful approach was a sensitive, respectful, and ethically-valuable process, and resulted in two outputs from this thesis in addition to the validation of music: the stimulus inclusion criteria, and a believable anxiety induction protocol that could be implemented ethically and with minimal resources.

A related strength was the use of the adapted MRC framework for the development and evaluation of complex interventions (adapted from MRC, 2000; 2008). This thesis reported the literature review, development, and exploratory trial phase of this adapted framework. Following these guidelines placed the work reported in this thesis as building blocks towards the development of an evidence base to place music listening as an empirically-supported intervention for individuals with anxiety disorders.

A number of limitations were present within this thesis.

Firstly, it should be noted that although stimuli were chosen carefully, and that a set of stimulus inclusion criteria were presented, only two stimuli were used within the analogue study. This is not to say that these are the only two stimuli that could be effective in this context, and indeed, future research should consider comparing the stimuli used here with other stimuli that do or do not comply with the criteria. Indeed, the stimuli were selected based on the development phase, but the procedures used were experimental. Future research could apply the stimulus inclusion criteria in a more systematic manner, taking into account recent advances into music emotion recognition systems (Eerola, 2012).

A second limitation is that although the anxiety induction protocol was designed to increase physiological arousal and worry, no specific measure was used to test the presence of the latter. Future research should include a measure of this, such as a worry questionnaire.

A third limitation is the lack of implementation of a study with a population with anxiety disorders. As previously mentioned, it was not within the scope of this PhD to conduct such a study, due to limitations of time and resources. However, a brief description of potential future research on this subject will be outlined in the "future research" section.

5.4 Future research

This section presents a number of suggestions for future research, relating to the stimulus inclusion criteria, the anxiety induction protocol, and the music effect.

5.4.1 Stimulus inclusion criteria

As already discussed, stimulus inclusion criteria were synthesised and used to select stimuli, but were not specifically tested. Further research could evaluate, extend and refine the stimulus inclusion criteria by comparing stimuli meeting differing amounts of these criteria, or stimuli meeting all the criteria but differing in other ways, in the context of inducing worry-based anxiety. It is important to bear in mind that, although these stimuli and stimulus inclusion criteria have been shown to be effective in reducing anxiety within the experimental work of this thesis, that there is a body of literature supporting the benefits of preferred music. Preferred music was not the focus of this thesis, due to the priority given to creating as controlled an environment as possible in this first stage. However, future research could examine the effects of using preferred music which met the criteria in comparison with preferred music which did not meet the criteria. This would provide an opportunity to consider different mechanisms of musical emotion induction, such as episodic memory, evaluative conditioning, and aesthetic judgement.

5.4.2 Anxiety induction protocol

As significant increases were seen in physiological arousal and subjective anxiety in response to the anxiety induction protocol, future research could use the anxiety induction protocol to examine the effectiveness of various interventions in a situation analogous to an anxiety disorder. This protocol was specifically designed with reference to an auditory stimulus, presented during the 'mental visualisation' exercise, and as such the protocol in its current form would be best suited to testing other auditory stimuli. However, the protocol could be adapted to place the experimental, manipulation, phase at different points. For example, interventions promoting resilience to anxiety responses could be presented immediately after time 1 (baseline), and before the anxiety induction protocol was introduced.

The protocol itself could also be examined further by including measures of dysfunctional perseverative thought, such as worry. Of particular interest would be to compare these scores with participants randomised to either the protocol used in this thesis, or in a protocol which replaced the mental visualisation exercise with a presentation preparation period. It would also be of interest to implement the anxiety induction protocol with neither music or white noise played, as a means of exploring participants' responses without external stimuli being presented.

5.4.3 Music effect

White noise was chosen as the control stimulus for the analogue study because it provided auditory stimulation, and as such was more controlled than the alternative, silence. Also, it provided an opportunity to ask participants in both conditions to wear headphones, further minimising differences between conditions. Analyses suggested that there were no differences in any of the measures between time 2 and time 3 for those in the white noise condition, suggesting that the white noise was not associated with an increase or decrease in subjective anxiety or physiological arousal. However, it would be interesting to explore the difference between white noise and silence as control conditions within this context, and as such future research exploring music in response to the anxiety induction protocol could use more than one control stimulus.

As previously mentioned, it would be of interest to use measures of negative perseverative thought, such as worry, in future research. In addition, only state (as opposed to trait) anxiety was measured in the experimental work in this thesis. This was because we were interested mainly in the anxiety induced by the intervention, rather than the participants' everyday predisposition to anxiety. However, future research could include a trait anxiety or neuroticism questionnaire to examine how the anxiety induction and listening phase affected those with high trait anxiety or neuroticism.

5.4.3.1 Clinical study

The most prominent next avenue for future research is in the testing of music listening with a sample of people with anxiety disorders.

The purpose of this PhD was to assess the state of the evidence for music listening as a potential treatment option for those with anxiety disorders. The evidence suggested that further study on this subject is warranted, in the form of a definitive RCT (as per the MRC framework).

This definitive RCT would aim to investigate the effects of music listening with a sample with anxiety disorders. As in the analogue study, the definitive RCT would use a parallel design. Participants would be recruited from a local NHS mental health service, and would need to meet diagnostic criteria for an anxiety disorder, or have already received a diagnosis of this. Ethical approval would be obtained from the NHS before proceeding with this research.

In the first instance, the stimuli tested in the analogue study could be used, as this provides the most controlled environment. However, it would be particularly interesting for future research to take an approach that combined the stimulus inclusion criteria with a focus on preferred music. As such, a researcher could meet with participants to discuss their preferred music, and these could be examined in conjunction with the stimulus inclusion criteria. However, it would be difficult to retain a controlled environment.

The anxiety induction protocol would not be used with a clinical population, as this was designed to model anxiety disorders in a general population. In a study with a clinical population, music listening could be integrated into a CBT session. This thesis reported results where listening to music was associated with decreased subjective anxiety and pulse rate in response to an anxiety induction protocol. These results suggest that music listening can be effective when participants are experiencing high levels of anxiety. We can translate this to a population with anxiety disorders by incorporating music listening into elements of a therapy session where anxiety is likely to be high, such as during exposure. For the purposes of this experiment, this exposure should be carried out within the therapy session. As such imaginal, rather than in vivo, exposure would be most appropriate.

Another possibility involves the integration of music listening into the cognitive restructuring element of a therapy session. In the literature review, I suggested that listening to music could reduce worry by manipulating affect, as per the mood-as-input model of perseverative thought. Optimal or preferred music could be played immediately preceding the cognitive restructuring element, or preceding the therapy session itself.

It should be noted that there are limitations in moving from a non-clinical to a clinical study. The proof-of-concept study reported in this thesis used an anxiety induction protocol that was designed to create a situation that was in some ways analogous to an anxiety disorder, specifically focusing on activating the processes of increased physiological arousal and negative perseverative thought, namely worry.

Increased physiological arousal, a key symptom experienced by those with anxiety disorders, especially when encountering a trigger stimulus, was promoted, and results showed greatly and significantly increased physiological arousal (measured by pulse rate and skin resistance) in response to the anxiety induction protocol. This aligns with the increased physiological arousal frequently experienced as part of the anxiety response by those undergoing exposure therapy.

As discussed in the literature review, worry, a type of negative perseverative thought, has been considered a core element of anxiety disorders, and stopping persevering with this type of thought has been identified as a particular difficulty experienced by those with anxiety disorders. Promoting worry was an aim of the anxiety induction protocol. The impending presentation, paired with the mental visualisation exercise, was designed to activate this process. The upcoming presentation was intended as a context and trigger for the worry, and the mental visualisation exercise was intended to promote continuing perseverative thought. However, because of the lack of worry measure, there is no indication of the success of this attempt to promote worry.

Although physiological arousal and worry were selected as particularly relevant process to include when modelling an anxiety disorder, they do not comprehensively represent an experience of having an anxiety disorder. This should be borne in mind when moving to a clinical study. Working with a general population in the proof-of-concept study allowed a focus on the two chosen processes (worry and physiological arousal), but the experience of an anxiety disorder is more than these two components, and this should be considered when designing a clinical study. Focusing on elements of therapy where physiological arousal and worry are being addressed, such as exposure therapy and cognitive restructuring, respectively, would be a useful means of continuing this research, but nevertheless these components of treatment are already complex, and adding music could serve to increase this complexity, adding questions: Where and when should music be introduced within a therapy session? How best can we measure the potential effect of music in this session? These questions should be addressed with further pilot work with a clinical population, taking a phased approach as implemented in this thesis.

5.5 Implications

The stimulus development work provides both specific and general recommendations for stimuli to use for lowering anxiety (that is, increasing positive valence and lowering arousal). Specifically, *The Swan*, by Saint-Saëns, and *Dawn* and *The Secret* by Dario Marianelli are suggested as optimal stimuli. Generally, a set of stimulus inclusion criteria are introduced as a means of selecting future stimuli: quiet dynamic, clear rhythm, major mode, simple harmony, consonance, slow tempo, legato articulation, lack of accentuation, and minimal sudden changes.

The anxiety induction protocol presented in this thesis provides a resource- and time-efficient means of modelling the increased physiological arousal and perseverative thought associated with anxiety disorders. This could provide a means of conducting analogue studies on various brief interventions for treating anxiety disorders as a means of establishing proof-of-concept before moving on to work with a clinical population. Indeed, this protocol could be used to model any disorder that contains negative, dysfunctional, perseverative thought and increased physiological arousal.

The results from the analogue study suggested that music listening was an effective means of reducing subjective anxiety in response to a situation analogous to an anxiety disorder. Pending future research with people with anxiety disorders, this could be a new component of treatment for people with anxiety disorders. As previously suggested, this could be particularly effective as a relaxation technique to use during exposure, or as a means of reducing negative mood, and therefore worry, before cognitive restructuring.

With reference to exposure therapy, music listening could be used as a lone relaxation technique or in conjunction with another technique, such as progressive muscle relaxation. Listening to music could occur within a therapy session, or outwith therapy, as a self-regulation strategy. Indeed, it has been argued that listening to music could function as a coping strategy for those with internalising psychopathologies such as depression or anxiety (Miranda, Gaudreau, Debrosse, Morizot, & Kirmayer, 2012), because music listening provides individuals with a way to be in control of their own emotional regulation (Miranda & Claes, 2009; van Goethem & Sloboda, 2011), especially with the current portability and availability of music (Skånland, 2013). With reference to cognitive restructuring, music's ability to regulate affect could decrease worry, as per the mood-as-input model of perseverative thought, which posits that negative affect contributes to dysfunctional perseverative thought, such as worry.

According to the MRC's guidance for the development and evaluation of complex interventions (2000; 2008), it is unlikely that an experimental trial will be able to accurately predict the effects of an intervention in a real-life, treatment setting. Because of the need for experimental control, such trials often lack ecological validity, providing little connection with situations they were designed to test. As such, long-term implementation or surveillance is recommended to observe how an intervention works in treatment.

The proof-of-concept study reported in this thesis was indeed an experimental setting designed to be as controlled as possible. Ecological validity was sought in a number of ways. Firstly, real musical stimuli were used, which can be considered more ecologically valid than using artificial, custom-made stimuli. Secondly, the anxiety induction protocol, namely the presentation, was designed to have maximum relevance for the participants. Presentations are a form of assessment often used in Higher Education, and students were specifically recruited for this reason.

Furthermore, the focus of the presentation was the subject that the participant studied, increasing personal relevance.

However, in other ways ecological validity was lacking. Although the presentation was designed to approximate a relevant, real-life situation, the inclusion of the mental visualisation exercise, specifically designed to promote the perseverative negative thought associated with an anxiety disorder, was artificial, and therefore could be seen as decreasing ecological validity. Similarly, the study protocol did not replicate a treatment session, or course of treatment, for anxiety disorders, and this is where ecological validity is most absent. The proof-of-concept study was not designed to be a comprehensive, ecologically valid representation of treatment, rather to be a means of conducting preliminary investigations into the potential effects of music listening in the treatment of anxiety disorders. It is important to remember that future studies into this area, especially those with a clinical population, should strive for maximum ecological validity, now that proof-of-concept has been established. This will be particularly relevant in studies observing long-term implementation and surveillance.

Considering the conceptualisation presented in this thesis, music listening could be more relevant for some diagnostic disorders than others, as presented and discussed in DSM-5. The benefits of music listening were conceptualised in this thesis as relating to its ability to regulate physiological arousal and decrease dysfunctional negative perseverative thought, such as worry (via the mechanism of promoting positive affect).

As such, music listening, the intervention presented in this thesis, is argued to be of particular relevance to those disorders where increased physiological arousal or dysfunctional perseverative negative thought are components of the manifestation, and where combatting these responses are considered targets of treatment.

This will now be considered with reference to DSM-5, with a particular focus on the following diagnostic disorders: generalised anxiety disorder, panic disorder, specific phobia, and social anxiety disorder.

Generalised anxiety disorder is particularly relevant because of the prominence of worry within this disorder. Although worry was not directly tested in the experimental work in this thesis, it was a key element of the conceptualisation. Particular focus was given to the mood-as-input hypothesis of perseverative thought, which posits that one's affective state can impact on one's dysfunctional perseveration of negative thought, and to studies exploring this hypothesis (such as Meeten & Davey, 2012). Meeten and Davey found that compared to those primed with negative affective states, those primed with positive affective states experienced decreased perseveration of negative thought when told to use an "as many as can" stop rule. As such, interventions promoting positive affect are theorised to decrease dysfunctional perseveration of worry, which is a central aim of treatment for generalised anxiety disorder.

Panic disorder, specific phobia, and social anxiety disorder are relevant to the intervention presented in this thesis, music listening, because of the surges of increased physiological arousal that are experienced with these disorders, sometimes in the form of panic attacks, which include symptoms such as increased pulse rate and sweating. As discussed in the literature review, music listening has a demonstrated capacity to reduce physiological arousal in response to stress-inducing stimuli, although this is not always consistent between studies because of the individual variability of these measures. In the proof-of-concept study reported in this thesis, no significant difference between conditions were found for pulse rate or skin resistance in the 3 x 2 ANOVAs. However, simple contrasts showed a significant reduction in pulse rate between the anxiety induction (time 2) and the experimental phase (time 3) in the experimental condition, but not in the control condition.

Panic disorder includes the occurrence of panic attacks, paired with concern about their occurrence. Music listening could function as a coping strategy to be used to reduce these physical symptoms of anxiety, both with panic disorder and with manifestations of other anxiety disorders that include panic attacks, including specific phobia and social phobia.

With specific phobia, an individual is "fearful or anxious about or avoidant of circumscribed objects or situations" (APA, 2013, p. 189). An anxious response is elicited by these stimuli, and the response is sometimes experienced as a panic attack. Specific phobia may be most similar to the situational anxiety that has been studied in reference to music listening (as explored in the literature review), because of the tangible, external, situation-dependent trigger.

Social anxiety disorder is characterised by an individual being "fearful or anxious about or avoidant of social interactions and situations that involve the possibility of being scrutinised" (APA, 2013, p. 190). One facet of this is performance anxiety, which can relate to public performance activities such as giving a speech or presentation. With social anxiety disorder, the individual is concerned about being judged negatively. Those with social anxiety disorder can experience panic attacks as well as anticipatory anxiety, such as worry.

In addition to the physiological symptoms experienced and the presence of anticipatory anxiety, social anxiety disorder is of particular relevance to the proof-of-concept study reported in this thesis because of the parallels with the anxiety induction protocol that was developed in the pilot study and used in the proof-of-concept study. The protocol was designed to be an anticipatory, psychosocial stressor, and to focus on performance in the form of a presentation. The presentation task was designed to be relevant to the individual, and to put them in a situation which resembled a performance situation they would likely experience in real life, namely to do a presentation about the subject they studied. Social-evaluative threat was promoted by the impending presentation itself, by the proposed audience, and by the marking scheme.

Although worry is most frequently discussed in relation to generalised anxiety disorder, it has been implicated as a feature within all anxiety disorders (Barlow et al., 2002), and as such music listening's theorised capacity to reduce perseverative thought could be useful for all manifestations exhibiting dysfunctional perseverative thought such as worry. This could also have relevance to specific phobia, social phobia, and panic disorder, where the individual may experience catastrophic thinking about the trigger stimulus, such as believing a dog is likely to bite, individuals are likely be judgemental, or panic attack symptoms are signals of life-threatening illness.

This brings us back to the mood-as-input hypothesis of perseverative thought, and studies exploring this hypothesis. As discussed in the literature review, the catastrophising interview, comprising a process where participants are encouraged to generate increasingly catastrophic outcomes to situations, has been used to promote perseverative thought in the context of the mood-as-input hypothesis. This has relevance to the disproportionate level of danger often perceived by those with specific phobia, social phobia, and panic disorder in response to their trigger stimuli. In comparison to negative affective states, promoting positive affective states was found to decrease this generation of catastrophised outcomes. Therefore music listening, with its capacity to promote positive affective states, has the potential to impact, not only on the physiological arousal experienced by those with specific phobia, social phobia, and panic disorder, but also on the catastrophic thinking associated with a disproportionate perception of danger.

5.6 Summary and contribution

This thesis made a significant contribution to knowledge in three main ways, by introducing 1) criteria to select optimal stimuli for reducing anxiety; 2) an effective and resource-efficient anxiety induction protocol designed to model an anxiety disorder; and 3) evidence to support two effective music listening stimuli for reducing anxiety in a situation analogous to an anxiety disorder, in the form of an exploratory trial as part a framework adapted from those developed by the MRC. The primary contribution from this thesis is evidence that supports testing a music listening intervention with a population with anxiety disorders. This evidence provides a building block towards music listening becoming an empirically-supported intervention for individuals with anxiety disorders.

This emerging evidence base for music listening in the treatment of anxiety disorders contributes to both clinical psychology and music psychology. For clinical psychology, a potential intervention has been introduced that could improve treatment for those with anxiety disorders. For music psychology, an application has been investigated for decades of research exploring music listening's capacity to evoke emotional responses and to reduce anxiety in a variety of health settings. Working towards an evidence base for music interventions in health settings is difficult: Because of the complexity of music, and of emotional responses to music, it can be difficult to develop experimental designs that can reflect the benefits of music in health settings while remaining robust. The experimental work reported in this thesis was informed by the MRC's guidelines for the development and evaluation of complex interventions and by the desire to create a maximally controlled, rigorous, and transparent experimental protocol. As such, the work in this thesis not only presents a potential application for music psychology research, but also a vein of hope, an illustration of the translation of music psychology evidence into a potential intervention for a discipline with evidence at its core, clinical psychology.

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Appendix A Music rating questionnaire

Please rate each musical example by circling the number you feel best fits for

- Arousal (on a spectrum from to deactivated (-3) to activated (+3), with 0 being neither deactivated nor activated)
- Valence (on a spectrum from unpleasant (-3) to pleasant (+3), with 0 being neither pleasant nor unpleasant

Try to rate how the music makes you feel, rather than the emotion you might recognise within the music

You may use the "comments" sections after each set of scales to add any further comments on the music.

Name: ____

Sex: M F

Age (in years):____

Native language: ____

AROUSAL

-3 -2 -1 0 +1 +2 +3

Deactivated Neutral Activated

VALENCE

-3 -2 -1 0 +1 +2 +3

Unpleasant Neutral Pleasant

Further comments:

____

____

____

Appendix B Exploratory study 1: Demographic questionnaire

Part 1: Personal information

Name (or initials): ____

Date of birth: ____

Sex: M F (please circle as appropriate)

Part 2: Musical training

Have you had any formal music lessons?

Y N (please circle as appropriate)

If yes, please specify which instrument(s) (or mark "voice" or "theory") you have learned, how long you learned each for, and the highest qualification you achieved

1 _______________ ______ years Highest qualification________________________

2_______________ ______ years Highest qualification________________________

3_______________ ______ years Highest qualification________________________

4_______________ ______ years Highest qualification________________________

5_______________ ______ years Highest qualification________________________

6_______________ ______ years Highest qualification________________________

Appendix C Exploratory study 1: Music questionnaire

Please rate your **liking** of the music you just heard from -3 to +3 (-3 strongly disliked, 0, neither liked nor disliked, +3 strongly liked)

-3	-2	-1	0	+1	+2	+3
Strongly disliked			Neutral			Strongly liked

Please rate how **physically calm** or **tense/energetic** you felt while listening to the music (-3 extremely tense, 0, neither tense nor calm, +3 extremely calm)

-3	-2	-1	0	+1	+2	+3
Extremely tense/energetic			Neutral			Extremely calm

Please rate how **positive (happy)** or **negative (sad)** you felt in response to the music (-3 extremely unpleasant, 0, neither unpleasant nor pleasant, +3 extremely pleasant)

-3	-2	-1	0	+1	+2	+3
Extremely negative			Neutral			Extremely positive

How **familiar** were you with the music? (Please circle ONE number as appropriate)

1 – I've never heard that music before

2 – I might have heard that music before

3 – I have heard that music before but couldn't identify it

4 – I definitely know that music, and could identify it

Appendix D Exploratory study 1: Final questions

Part 1: Liking

Earlier you rated your liking of the music. Please answer the following questions regarding whether you think this changed how you felt when listening to each piece.

Piece 1

Did you like, dislike, or feel neutral towards the music? (Circle ONE answer)

Disliked   Neither liked nor disliked   Liked

Do you think this affected how the music made you feel?

(Circle ONE answer for each line)

More tense/energetic   Neither more calm nor more tense/energetic   More calm

More negative (sad)   Neither more negative nor more positive   More positive (happy)

[*Repeated for Piece 2 and Piece 3]*

Part 2: Familiarity

Earlier you rated your familiarity with the music. Please answer the following questions regarding whether you think this changed how you felt when listening to each piece.

Piece 1

1) Were you at all familiar with the music? (circle ONE answer)

a) Never heard
b) Might have heard
c) Have heard, couldn’t identifu
d) Have heard, could identify

2) Did you associate this music with one or more specific memories?

YES NO (circle ONE answer)

If YES, answer question 3). If NO, continue to Piece 2

3) If "YES" to 2), do these memories evoke (circle ALL that apply)

Positive emotions Negative emotions Neither positive nor negative emotions

[*Repeated for Piece 2 and Piece 3]*

Part 3: Personal information

Have you been diagnosed with any mental health conditions?

YES NO (circle ONE answer)

If applicable, please provide details of any treatment you are receiving for this, including specific details and dosage of any medication:

____

____

____

Have you been diagnosed with any heart conditions?

YES NO (circle ONE answer)

If applicable, please provide details of any treatment you are receiving for this, including specific details and dosage of any medication:

____

____

____

Please give details of any caffeine, tobacco, or alcohol you have consumed in the past 3 hours:

____

____

____

Do you have any comments or suggestions about the study, including what you liked, didn't like, and what could be improved?

____

____

____

____

____

____

Appendix E Stimulus studies: Information sheet

Information Sheet: Music listening study

This study has been approved by the University of Edinburgh's (UoE) School of Health in Social Science Research Ethics Committee

Name and contact details of investigator:
Ellen Spaeth e.c.spaeth@sms.ed.ac.uk

What are the aims of the project?

To see how listening to music affects heart rate and skin conductance.

What will be involved?

You will listen to some music while we measure your heart rate and skin conductance through a wrist band, and answer some questions.

How long will it take?

In total, the study should take approximately 40 minutes.

Do I have to take part?

You may decide to stop taking part in the study at any time without explanation. You have the right to ask that any data you have supplied up to that point be withdrawn and/or destroyed.

You have the right to have your questions about the procedures answered (unless answering these questions would interfere with the study's outcome). If you have any questions as a result of reading this information sheet, you should ask the researcher before the study begins.

Benefits and risks

There are no known benefits or risks for you in this study.

Cost, reimbursement, and compensation

Your participation in this study is voluntary.

What happens to my data/personal information?

Paper questionnaires will be transferred into electronic data. The paper questionnaires will then be destroyed. All information stored electronically will be anonymised without any identifying features.

Who can I contact for further information?

If you would like any more information about the study, please contact Ellen Spaeth at e.c.spaeth@sms.ed.ac.uk

Appendix F Visual Analogue Scales

For each of the five words below, please mark the place on the line that best matches **how you feel right now**. Please mark this with an X, or a small mark that crosses the line, rather than with a circle.

Not at all joyful Very joyful

Not at all calm Very calm

Not at all worried Very worried

Not at all guilty Very guilty

Not at all angry Very angry

Not at all upset Very upset

For each of the words “happy” and “sad”, please mark the place on the line that best matches **how you feel right now**. Please mark this with an X, or a small mark that crosses the line, rather than with a circle.

Not at all happy Very happy

Not at all sad Very sad

Appendix G Pilot: Music questionnaire

Earlier, you listened to some music. The following questions relate to the music you listened to.

Liking

1. How much did you **like** the music?

Please circle a number from -3 to +3 (-3 = strongly disliked, 0 = neither liked nor disliked, +3 = strongly liked)

-3	-2	-1	0	+1	+2	+3
Strongly disliked			Neutral			Strongly liked

Familiarity

2. How **familiar** were you with the music? *(Please circle **one** answer)*

a – I've never heard that music before

b – I might have heard that music before

c – I have heard that music before but couldn't identify it

d – I definitely know that music, and could identify it

*If you answered **a**, you have completed the **music** questionnaire.*

*If you answered **b, c, or d,** please continue to question 3.*

3. Do you associate any of the music you heard with a specific event or memory? *(Please circle **one** answer)*

Yes **No**

*If **Yes**, please move to question 4.*

*If **No**, please move to question 6.*

4. Please give details of the specific event or memory you associate the music with:

____

____

____

____

5. Was the event or memory positive, negative, or neither *(Please circle **one** answer)*

Positive

Negative

Both positive and negative

Neither positive nor negative

6. Have you played this music (on instrument or voice)?

*(Please circle **one** answer)*

Yes **No**

If **Yes**, please specify the name of the instrument (or voice) ______________________

Appendix H Pilot: Tasks questionnaire

The following questions relate to the **mental visualisation exercise** you did while preparing for the presentation**.**

To what extent do you agree with the following statements? *(Please tick **one** box per row)*

	Strongly disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Strongly agree
I was excited about the presentation					
I hate giving presentations					
I was worried about people judging me negatively in the presentation					
I thought I would give a bad presentation					
I enjoy giving presentations					
Thinking about the previous presentation made me feel ready to present					
Thinking about the previous presentation made me feel more nervous about presenting					
I didn’t believe I’d have to give a presentation					
I thought I would give a great presentation					

Appendix I Pilot: Personal information questionnaire

1. Name: ____

2. Date of birth: ____

3. Gender: Male Female Other

*(Please circle **one** answer)*

Musical Training

4. Please specify any instrument(s) (or mark "voice" or "theory") you have learned, how long you learned each for, whether you were self-taught or received lessons, and the highest qualification you achieved

Name of instrument ___________________________________

Length of time learned ________ years

Highest qualification ___________________________________

Name of instrument ___________________________________

Length of time learned ________ years

Highest qualification ___________________________________

Name of instrument ___________________________________

Length of time learned ________ years

Highest qualification ___________________________________

If you run out of space, please ask the investigator for more paper.

Health

5. Do you suffer from a recognised mental or physical health condition? *(Please circle **one** answer)*

Yes *(please provide details here)*

____

____

____

No

If **No**, please go to question 6. If **Yes**, are you receiving treatment for the condition(s)? *(Please circle **one** answer)*

Yes *(please provide details here)*

____

____

____

No

6. In the past 4 hours, have you consumed any caffeine, alcohol, tobacco, medication (prescribed or otherwise), or other substances? *(Please circle **one** answer)*

Yes *(please provide details here)*

____

____

____

No

Appendix J Pilot: Information sheet

Participant information sheet: **Mental visualisation study**
This study has been approved by the University of Edinburgh's (UoE) School of Health in Social Science Research Ethics Committee
Name and contact details of investigator: **Ellen Spaeth e.c.spaeth@sms.ed.ac.uk**
What are the aims of the project? To monitor your pulse rate and skin conductance, and how you feel, during a mental visualisation task. **What will be involved?** You will do a mental visualisation activity while we measure your pulse rate and skin conductance through a wrist band and finger sensors. You will also answer some questions throughout the study. **How long will it take?** In total, the study should take an hour or less. **Do I have to take part?** You may decide to stop taking part in the study at any time without explanation. You have the right to ask that any data you have supplied up to that point be withdrawn and/or destroyed. You have the right to have your questions about the procedures answered. If you have any questions as a result of reading this information sheet, you should ask the investigator (the person conducting the study) before the study begins. **Benefits and risks** There are no known benefits or risks for you in this study. **Cost, reimbursement, and compensation** To thank you for participating in the study, you will be offered a £10 gift voucher

for Amazon on completion of the study.

What happens to my data/personal information?
Paper questionnaires will be transferred into electronic data. The paper questionnaires will then be destroyed. All information stored electronically will be anonymised without any identifying features.

Who can I contact for further information?
If you would like any more information about the study, please contact:

Investigator: Ellen Spaeth (e.c.spaeth@sms.ed.ac.uk)
Supervisor: Professor Matthias Schwannauer (m.schwannauer@ed.ac.uk)

Appendix K Pilot: Informed consent form

Mental visualisation study

By signing below, you are agreeing that: (1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are taking part in this research study voluntarily (without coercion).

____

Participant's Name (Printed)*

________________________________ ________________________________

Participant's signature* Date

________________________________ ________________________________

Name of person obtaining consent Signature of person obtaining consent

**Participants wishing to preserve some degree of anonymity may use their initials (from the British Psychological Society Guidelines for Minimal Standards of Ethical Approval in Psychological Research)*

Appendix L Pilot and proof of concept: Mental visualisation exercise

Think of a specific time when you've done a public speaking task, such as a presentation, where you felt anxious, nervous, or stressed. Once you've chosen a specific event to think about, please spend 4 minutes thinking about the questions listed below, in reference to that event:

1) Did you have any thoughts that made you anxious, nervous, or stressed? What were those thoughts?

2) Were there any physical sensations that you experienced when you were anxious, nervous, or stressed? What were those physical sensations?

3) How do you think being anxious, nervous, or stressed affected your performance? Did it make you perform better? Or did it make you perform worse?

4) How do you think other people evaluated your public speaking? Why do you think that?

5) How could you have improved your public speaking performance? Consider body language, tone of voice, and content.

Appendix M Pilot and proof of concept: Presentation marking scheme

Participant ID: _____________

To what extent do you agree with the following statements? *(Please tick **one** box per row)*

	(1) Strongly disagree	(2) Slightly disagree	(3) Neither agree nor disagree	(4) Slightly agree	(5) Strongly agree
1. The participant showed good knowledge of their subject					
2. The presentation was well-structured					
3. The participant's body language was engaging					
4. The participant's body language was distracting					
5. The participant's tone of voice was confident					
6. Judging by the presentation, I think the participant will do well in their degree					

Appendix N Proof of concept: Participant recruitment advertisement

Vacancy Details

University of Edinburgh | Vacancy Search Results

Job Title	Mental visualisation study
Job Description	Participants are wanted for a research study exploring mental visualisation. Throughout the study your pulse rate and skin conductance will be measured by a wristband and finger sensors. You will also be asked to complete several short questionnaires.
Person Specification	To participate in this study, you must be a student at the University of Edinburgh. You must not have participated in the previous mental visualisation study run by Ellen Spaeth and colleagues in February.
Job Type	Other Not Specified
Method of Application	Please email the lead researcher if you would like to take part in the study or if you have any questions. Please put [MV study] as the subject of the email, and include a contact phone number. The lead researcher, or one of her colleagues, will then contact you to arrange a suitable time.
Careers Service Help	To find out how the Careers Service can help you with CVs, Application Forms and Interviews please go to the **Applications and Interviews** section of our website
Dates/Hours/Times Worked	The study will take around an hour. Time slots will be available between Wednesday 3rd April and Thursday 16th May.
Closing Date Comments	Apply as soon as possible.
Salary/Rate of Pay	£10 voucher for Amazon UK
General Location Information	Edinburgh
Specific Location Information	Teviot Place

This employer may be involved in other activities/events organised by the Careers Service (e.g. making a presentation on campus, running a careers or skills workshop or attending one of our careers fairs). Details of all Careers Service events can be found on our website in the 'What's Going On?' section.

Please remember to let the employer know that you heard about this vacancy through SAGE

Contact Name	Ellen Spaeth
Position	Lead Researcher
Address	School of Health in Social Science University of Edinburgh Apply by email
Email	e.c.spaeth@sms.ed.ac.uk

Appendix O Proof of concept: Personal information questionnaire

1. Name: ____

2. Date of birth: ____

3. Gender: Male Female Other *(Please circle **one** answer)*

Musical instruments

4. Have you ever learned any musical instruments? *(Please circle **one** answer)*

Yes **No**

If **No**, please continue to question **5**.

If **Yes**, please give details of the name of any instruments (or write "voice" or "theory" if appropriate), and how long you learned each for.

Name __________________________________ Length of time learned ___________

Name __________________________________ Length of time learned ___________

Name __________________________________ Length of time learned ___________

Name __________________________________ Length of time learned ___________

Health

5. Do you suffer from a recognised mental or physical health condition? *(Please circle **one** answer)*

Yes *(please provide details here)*

____

____

____

No

If **No**, please go to question 6. If **Yes**, are you currently receiving treatment for the condition(s)? *(Please circle **one** answer)*

Yes *(please provide details here, including name, dosage, and frequency of any medications, if relevant)*

No

6. In the past 4 hours, have you consumed any caffeine, alcohol, tobacco, medication (prescribed or otherwise), or other substances? *(Please circle **one** answer)*

Yes *(please provide details here, including name and quantity of substance, and how recently it was consumed)*

No

Exams

7. Do you have any upcoming exams (in April or May)? *(Please circle **one** answer)*

Yes *(please provide details here)*

No

If **No**, you have finished this questionnaire.

If **Yes**, please go to question **8**.

8. This question relates to how you are feeling **about any upcoming exams.** Please read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel **about any upcoming exams.***

	Not at all	Somewhat	Moderately	Very much
1. I feel calm	1	2	3	4
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	1	2	3	4
5. I feel content	1	2	3	4
6. I am worried	1	2	3	4

*This uses the STAI-SF, as developed by Marteau and Bekker (1992)

Appendix P Proof of concept: Tasks questionnaire

The following questions relate to the **mental visualisation exercise** you did while preparing for the presentation**.** To what extent do you agree with the following statements? *(Please tick **one** box per row)*

	Strongly disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Strongly agree
1. I was excited about the presentation					
2. I hate giving presentations					
3. I was worried about people judging me negatively in the presentation					
4. I thought I would give a bad presentation					
5. I enjoy giving presentations					
6. Thinking about the previous presentation made me feel ready to present					
7. Thinking about the previous presentation made me feel more nervous about presenting					
8. I didn’t believe I’d have to give a presentation					
9. I thought I would give a great presentation					
10. I was nervous about the presentation					